POWER

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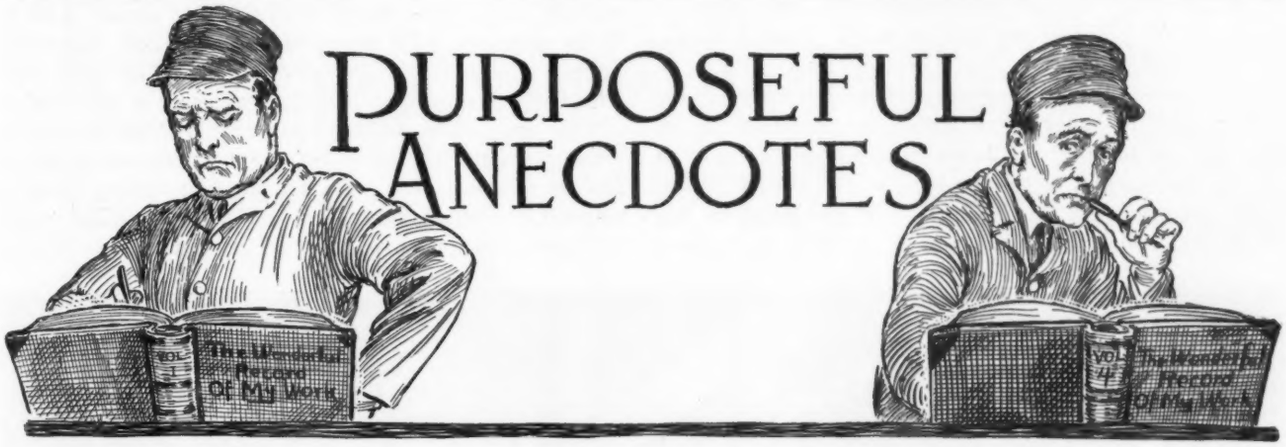


How I Earned My Raise

AFTER my first year in charge of our power plant I was told by the owner that my work was satisfactory—that I would be retained at the same salary.

The news, however, did not please me much. I had hoped for a raise. Why didn't I get it? Would I have to work another year at the same salary?

The more I thought about it, the more peevish I became, until I finally decided on a unique plan for throwing up my job. I would revenge myself by "heaping coals" of fire on the head of the owner. I would prove that I'm "game."

I began by working up a written "process system" that would enable my successor to pick up the plant where I left off, without difficulty.

I put down in black and white the peculiarities of our grates, boilers, draft, etc., and the method of firing that I believed to be best—

Position of ash doors, rate of feed of stokers, speed of fans, method of cutting out boilers, when to do it, method of cleaning, dangers—And other points that had given me trouble during my year in charge.

But I found that my grouch was beginning to leave. Writing about my plant made me THINK. I began to wonder if, after all, my methods were BEST. My interest increased. I studied. I experimented. And as a result, I learned that my old methods were NOT best, and I began putting BETTER methods in force.

I continued writing my process system, altering it wherever improvements in operation were made, and at the end of six months I had covered the entire plant. But I realized by this time that it was not yet at its best—that even better overall economy was possible and should be attained. I saw that we needed a little additional equipment and I could PROVE it with actual figures.

So, instead of resigning, as I first intended to do, I handed my process system to the owner, told him what I had done and what I had learned. I told him what was needed and why, and I won my point.

I did not have to wait the year out for my raise. TRY IT.

Boiler Plant of Union Brewery

By Thomas Wilson

SYNOPSIS—An isolated boiler plant of 1500-hp. capacity equipped with complete coal- and ash-handling systems. Boilers have the new marine settings, and special precautions have been taken to insure a minimum loss of draft between the stack and furnace.

An uptodate boiler plant, unusually complete for its size and containing the latest features in boiler-room design, has recently been completed by the Otto F. Stifel Union Brewing Co., in St. Louis. The commercial life of the old boiler plant was rapidly drawing to a close, and the early intention of enlarging the brewery made the new plant imperative. As a starter only the boiler house was erected, across the street from the brewery. It is the intention to erect an engine room adjoining, but at present the old equipment, consisting of three engine-driven ammonia compressors and two generating units, is supplied with steam at 150 lb. pressure from the new boiler house. The pipe supplying steam for the above machines and for industrial uses in the brewery passes through a tunnel under the street. At the delivery end the supply is controlled by an electrically operated valve.

The new building is of fireproof construction throughout, as it is made up of brick walls, concrete floor, tile and concrete roof, steel sash and ventilators, and no wood except the doors. The interior dimensions are 47x64 ft., and the height from the floor to the roof trusses is 38 ft. It is equipped with three 500-hp. vertical water-tube boilers, and there is space for one more of the same size. The boilers, shown in Fig. 1, now carry a pressure of 150 lb. gage, but eventually will supply steam at 175 lb. pressure to the equipment of the new engine room. A feature of the boilers is the marine-type setting recently adopted in stationary work to reduce the radiation and eliminate infiltration of air. It is made up of 4½ in. of "circle" firebrick and 3 in. of asbestos fiber covered by steel plate. The exterior furnace walls, made up of 9 in. of firebrick and 12 in. of common brick, are protected by ¼-in. asbestos board and the steel-plate covering. This construction prevents leakage from the sides, and as the stoker works under a ledge it is easy to block off the air from the front.

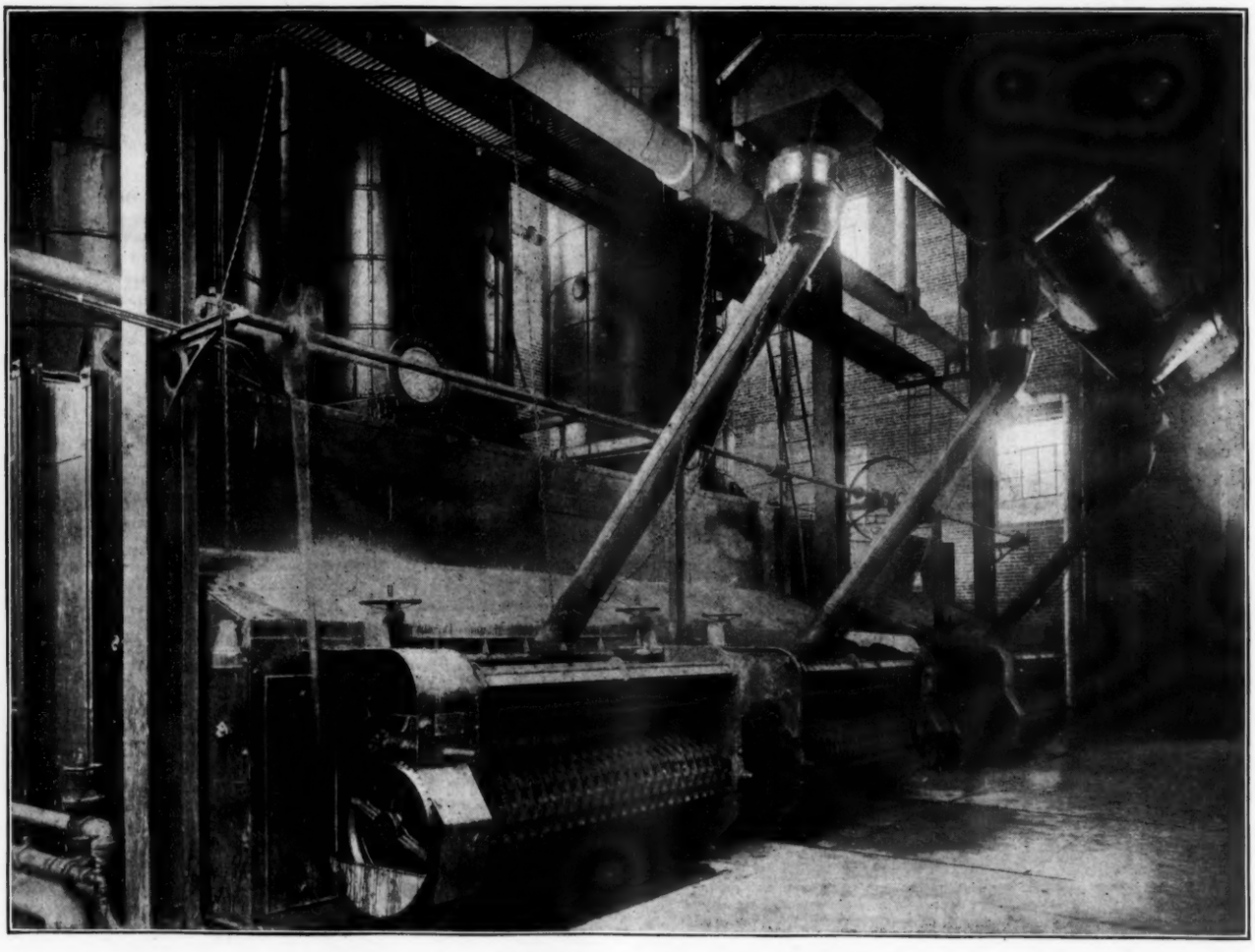


Fig. 1. Boiler House of the Union Brewing Co.

Stokers of the chain-grate type were installed, having an active width of 7 ft. 6 in., a length of 11 ft. 7 in. and an area of 87 sq.ft. To the 5000 sq.ft. of heating surface contained in each boiler, the above area bears a ratio of

1 to 57.5. This is somewhat higher than the usual 50 to 1, but in this particular case the grate surface was made less than the average for the following reasons: As fuel had to be carted eight blocks, it was decided in the interests of economy to use a high grade of Illinois

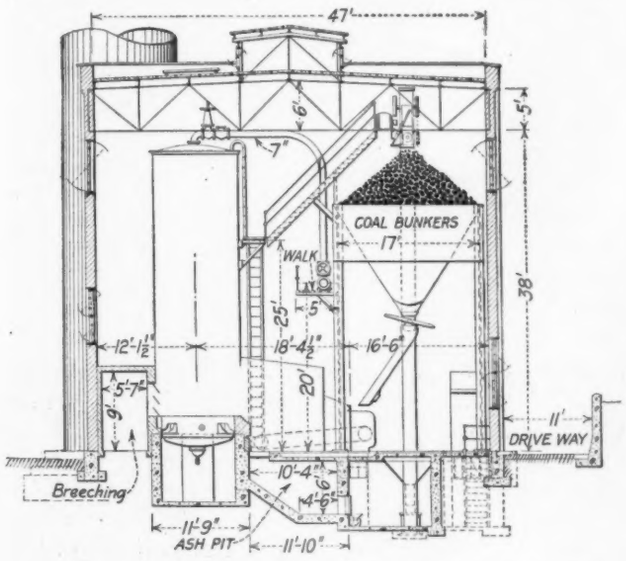


FIG. 2. TRANSVERSE SECTION OF BOILER PLANT

reduction of grate area was desirable and its installation an evidence of good engineering.

An inspection of the drawings will show that special precautions were taken to reduce to a minimum the loss of draft between the stack and the furnace. In the first place, under average conditions a boiler of the type installed shows a draft loss approximately only 0.2. This is from the boiler side of the damper to the entrance from the furnace. The low drop is partly due to the static effect of the hot gases rising in the first pass and dropping in the second pass after being cooled by coming in contact with the heating surface. Through three-wing dampers the gases discharge directly to a rectangular breeching built up from the floors and running straight to the stack. The breeching tapers toward the farthest boiler, but at the stack is 5 ft. 7 in. wide and 9 ft. high, giving an area of 50 sq.ft. in round numbers. It is made of tile, firebrick lined, and has a run of 57 ft.

The stack is one of the finest for its size in St. Louis. It rises 185 ft. above the boiler-room floor and has an internal diameter of 7 ft. 6 in. The shell is made of a special radial tile filled with reinforced concrete, and for a height of 70 ft. is lined with firebrick. An air space of 3 in., unfilled, separates the lining from the shell. For a gas temperature ranging around 500 deg. and allowing 100 lb. of gas per horsepower, the stack is figured to

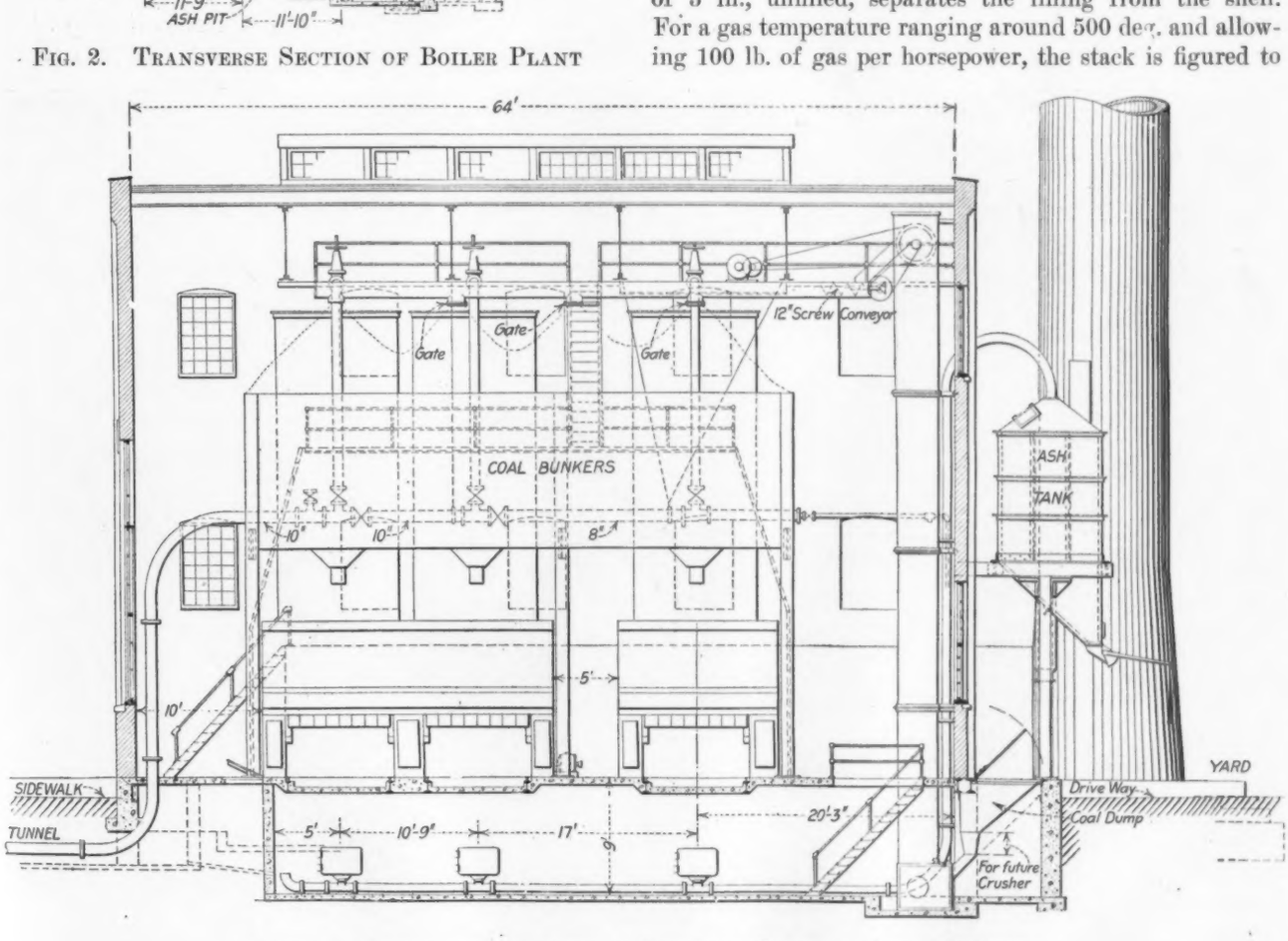


FIG. 3. LONGITUDINAL SECTION SHOWING GENERAL ARRANGEMENT

washed coal. This quality of coal requires less grate surface than an inferior grade as it contains less impurities, and as it is high in volatile more of it can be burned per square foot of grate than coals containing more ash or higher in fixed carbon. For these reasons and because an excellent stack had been provided, which is capable of producing a strong draft over the fire, a

produce a draft of 1 in. of water at the base for the four boilers and 1.1 for the three boilers now installed. For higher temperatures the draft will be slightly greater. While clean, the breeching should not cause a drop of more than 0.1 in. and the return from the breeching into the stack 0.05 in. Taking the boiler farthest from the stack, interference by the gases from the two other boilers

will cause a drop of 0.1 in.—0.05 for each boiler. The right-angle turn of the gases in the breeching at the outlet from the boiler will cause a loss of 0.05 in., the damper another 0.05 in., the boiler 0.2 in. and the right-

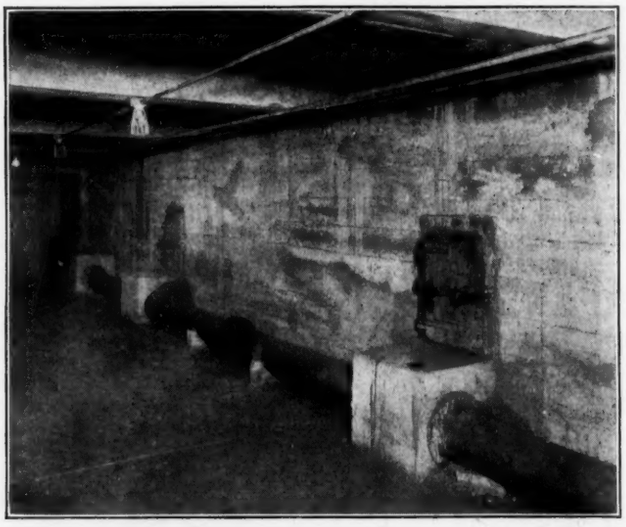


FIG. 4. PART OF ASH-REMOVAL SYSTEM IN FRONT OF ASHPITS

boilers approaching the stack the draft over the fire will be slightly higher, but with the three-wing dampers the intensity can of course be varied to suit the load conditions, thickness of fuel bed and the character of the coal.

It may be of interest to check the relative areas of stack, breeching and grate, and these will be compared on the basis of three boilers, as the fourth, when installed, will in all probability be held as a reserve unit. With an internal diameter of 7.5 ft., the stack has an area of 44.2 sq.ft., while the breeching, as previously stated, has 50 sq.ft. The breeching, then, is a trifle larger than the stack, as it should be, and its area bears a ratio to the connected grate surface of 1 to 5. This conforms with the average ratio adopted in recent practice. Each square foot of sectional area in the stack is intended to serve 5.9, or nearly 6, sq.ft. of grate, and each square foot of breeching 5.2 sq.ft. of grate. Per boiler horsepower, still considering the three units, the stack has an area of 0.0294 sq.ft. and the breeching 0.0333 sq.ft.

Figs. 2 and 3 indicate the arrangement of the plant, the layout and size of the steam piping, and the provisions made for handling coal and ashes. A feature worthy of notice is the walks, giving ready access to the top of the boilers, the steam header and the screw conveyor over the

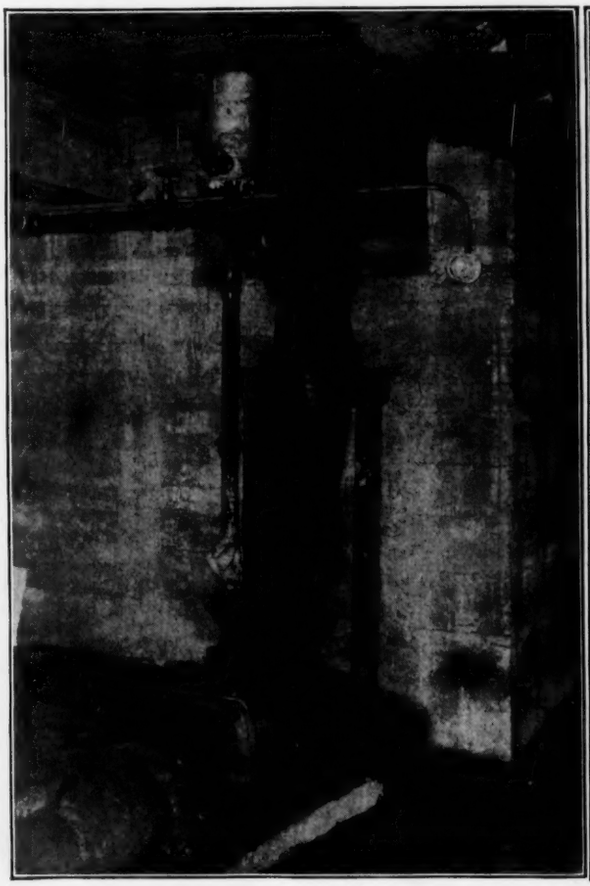


FIG. 5. BEND AT WHICH STEAM NOZZLE IS INTRODUCED

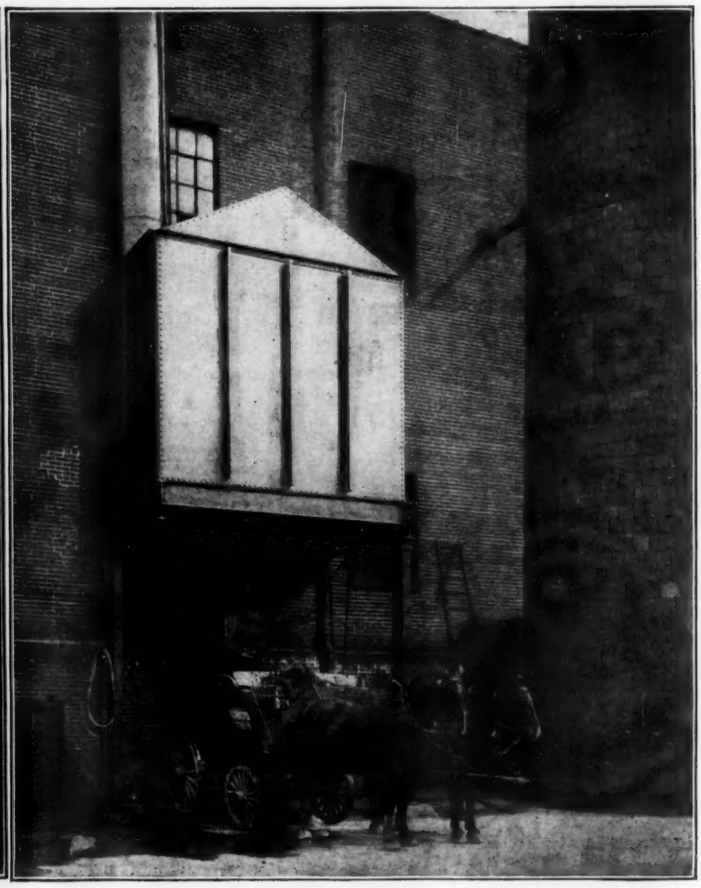


FIG. 6. THE RECEIVING TANK FOR THE ASHES

angle turn from the furnace up into the boiler, 0.05 in. The various drops total 0.6 in., and deducting this loss from 1.1 in. leaves a draft of 0.5 in. over the fire for the farthest boiler. With the fourth boiler installed the above draft would be reduced to about 0.35 in. For the

bunkers. As previously stated, coal is carted to the plant and dumped from the yard into a hopper shown at the right in Fig. 3. Provision has been made here for a coal crusher, which may be installed at a future date. From the hopper the coal slides into the boot of a bucket

elevator and may be hoisted at the rate of 30 tons per hour. At the top of the boiler room the coal is transferred to a screw conveyor and may be dumped through any one of three gates into a suspended steel bunker of 175 tons' capacity. A separate spout for each boiler carries the coal to the hoppers of the stokers. All three stokers are eccentric driven from a shaft turned by a 5½-hp. motor.

Ashes are removed by a vacuum system using a steam nozzle to supply the motive power. As shown in Figs. 4, 5 and 6, this consists of about 100 ft. of 8-in. chilled cast-iron pipe having walls 1 in. thick, a steam nozzle and a tank to receive the ashes. The horizontal run in front of the ashpits is close to 50 ft. and the rise about 43 ft. The nozzle is located in the basement at the point where the pipe turns upward. Its location is shown in Fig. 5. The photograph was taken before the steam pipe leading to the nozzle had been fully covered. The far end of the ash pipe is left open, and when steam is turned on, air is pulled through the pipe at high velocity. Ashes raked from the pits into the pipe are carried along with the current of air, and when they pass the nozzle, are positively forced up into the tank by the jet of steam. Through a gate at the bottom of this tank the ashes are loaded into wagons and carted away.

The system was designed to handle 200 lb. of ashes per minute, or 6 tons per hour, with a steam pressure of 114 lb. at the nozzle. The nozzle is ⅝ in. diameter, and at the above rate will discharge against atmospheric pressure about 2000 lb. of steam per hour. Charging 22c. per 1000 lb. for steam, the cost for steam only per ton of ashes removed would be 6.4c. In a plant of this size additional labor should not be required to operate the system. The charge to add per ton for depreciation, interest on investment, etc., cannot be determined without knowing the amount of ashes removed per year or the life of the equipment, but at a rough estimate the total cost should not exceed 10 to 12c. per ton.

Feed water for the boilers comes from a 1000-hp. open heater in the old plant. It flows by gravity to the pumps, one of which is a 10x6x10-in duplex and the other a 12x7x12-in. simplex taken from the old equipment. The water lines are arranged to feed the boilers at either top or bottom, and for the present the water is fed at both points, with a view to reducing pulsations set up by the single pump. There is also a duplication of feed mains so that one pump may supply cold water for washing one or more boilers while the other is supplying the hot feed water as usual.

At present means for measuring water and weighing coal have not been provided. It is the intention, however, to install at an early date a water meter, coal scales below the bunker, a damper regulator and CO_2 apparatus. With these refinements so necessary for the keeping of accurate records, the plant, for its capacity, will be one of the finest in the country. Including building, stack, the fourth boiler and all equipment now installed, the total cost will reduce to $40 per boiler horsepower.

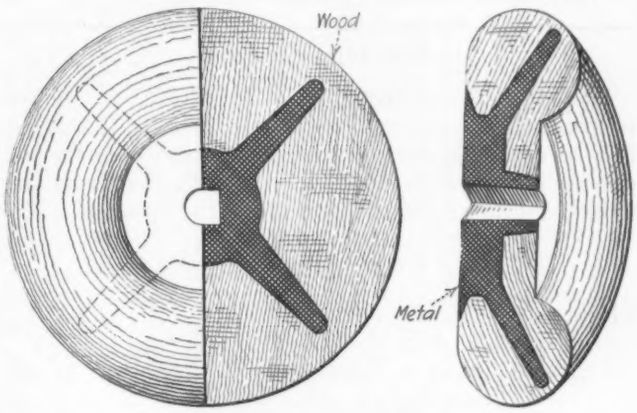
Ruebel & Wells, consulting engineers, of St. Louis, designed and erected the plant under the direction of Phillip Scheuerman, general manager of the brewery.

PRINCIPAL EQUIPMENT OF STIFEL BREWERY PLANT

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
3	Boilers	Vertical water-tube	500-hp	Generate steam	150-lb. pressure, natural draft, stokers	Wickes Boiler Co.
3	Stokers	Chain grate	87-sq.ft.	Serve boilers	Motor driven	Laclede-Christy Clay Products Co.
1	Motor	Direct-current	5½-hp.	Drive stoker shaft	110 volt, 1000 r.p.m.	Sprague Electric Co.
1	Ash removal system	Vacuum	8-in. pipe, ¾-in. nozzle	Convey ashes from pits to tank	Steam pressure 114 lb. at nozzle, capacity 200 lb. per min.	Girtanner-Daviess Engineering & Contracting Co.
1	Coal handling system	Bucket elevator and screw conveyor	30 tons per hour	Transfer coal to bunker	Geared to motor, ratio 7 to 1	Stephens-Adamson Mfg. Co.
1	Stack	Radial tile	185-ft. high, 7½ ft. dia.	Serve boilers	1 in. draft at base	Wiederholdt Construction Co.
1	Pump	Duplex	10x6x10-in.	Boiler feed	150-lb. steam pressure	Epping-Carpenter Co.
1	Pump	Simplex "Hooker"	12x7x12-in.	Boiler feed	150-lb. steam pressure	Reliance Machine & Tool Works
2	Lubricators	Force feed		Serve boiler feed pumps		Hills-McCanna Co.
1	Heater	Open	1000-hp.	Heat boiler feed water	Exhaust steam	Harrison Safety Boiler Works

"Kantsplit" Valve Handle

One of the annoyances in a steam plant is the cracking and working loose from their metal seats of wooden valve handles such as commonly used on water-column cocks and the like. This trouble renders the handles useless and wooden handles have in many cases been replaced by metal, which, when used with steam, becomes hot and disagreeable to handle.



SHOWING HOW THE "KANTSPLIT" VALVE WHEEL IS MADE

The "Kantsplit" handle seems to be so constructed as to prevent splitting and working loose from its bottom plate. The illustration shows how it is made. The handle is of birch or maple wood, which is used as a mold into which is cast a metal wheel, the spokes of which bind the fibers of the wood together and prevent it from splitting.

As the metal "freezes" to, and engages projections of, the top and bottom plate so as to make the finished handle one piece, the bottom plate cannot easily work loose.

The handle is inexpensive and is made by the Holton-Abbott Manufacturing Co., 61 Gorham St., West Somerville, Mass.

Figures on the cost of generation in small municipal plants are always interesting. The following are taken from the annual report of the 500-kw. municipal plant at Topeka, Kan., and include depreciation at 5 per cent., interest at 4 per cent. and taxes at 1.725 per cent.

Net cost per kw.-hr. at switchboard	$0.0165
Net transmission cost per kw.-hr.	0.00784
Gross cost per kw.-hr. at lamps, including all operating, overhead and fixed charges	0.0427
Net cost per arc lamp per year	24.31
Net cost per 100-watt series tungsten lamp per year	14.66

Interior Wiring for Lighting and Power Service--III

By A. L. Cook

SYNOPSIS—How to figure the sizes of branch circuits and feeders in lighting service for both direct- and alternating-current systems. The next installment will take up power circuits.

Two-Wire System

The two-wire system, previously described, is the simplest arrangement of lighting circuits. In laying out this or any other arrangement the voltage drop for the circuits must first be calculated. For direct-current circuits the drop can be calculated from the formula,

$$e = \frac{21.4 \times D \times I}{circ.mils}$$

where

e = Total drop in the two wires;
D = Distance in feet between the feeding point and the load; in other words, the distance one way;
I = Current in amperes.

To determine the size of wire for a given loss in volts the formula may be transposed to

$$Circ.mils = \frac{21.4 \times D \times I}{e}$$

The number 22 is sometimes used instead of 21.4 but the latter is satisfactory unless the wires are to be located in a very warm place. An example of the use of these formulas may be helpful. Suppose the feeder is No. 00 B. & S. (133,100 circ.mils.), the length of run 150 ft., and the load 50 amp.

$$e = \frac{21.4 \times 150 \times 50}{133{,}100} = 1.2 \text{ volts}$$

If it is required to find the size of wire for this circuit with a loss of 1.5 volts,

$$Circ.mils = \frac{21.4 \times 150 \times 50}{1.5} = 107{,}000$$

Referring to Table 7 (page 642, May 11 issue) it will be seen that the nearest size is No. 0, which is slightly smaller than required.

While any direct-current two-wire circuit can be calculated by means of these formulas, it is more convenient to use some form of chart. The one printed in Fig. 7 is based upon the formula already given and is a modification of a chart devised by R. W. Stovel and N. A. Carle (see *The Electric Journal*, June, 1908). If it is desired to find the drop for the feeder already calculated, start at 50 amp. on the lower left-hand side and follow vertically until this line crosses that for 00 wire; then pass horizontally to the right to the line marked 150 ft. and follow down vertically and read 1.2 volts.

To determine the size of wire as in the second problem, start with 1.5 volts at the lower right-hand side and follow up vertically to the 150-ft. line; then horizontally to the left to the line for 50 amp., which also crosses the No. 0 line at this point.

Suppose it is desired to find the drop when 6 amp. is carried by a No. 12 wire for a distance of 100 ft. The chart does not give a value for 6 amp., but the drop can be figured for 12 amp. and then divided by 2, since it will be half as great as for 12 amp. Using the chart, we obtain 4 volts, so the drop for 6 amp. would be 2 volts.

If it is desired to find the drop for 125 amp. carried on a 300,000-circ.mil cable a distance of 200 ft., the position of the 125-amp. line will have to be estimated between the 100- and the 150-amp. lines. Carrying this up to the 300,000-circ.mil line and then across to the right and down as before will show a drop of 1.8 volts.

Returning to the original problem, compare the size of wire required for 240 volts with that for 120. If the load is 50 amp. at 120 volts, this is $50 \times 120 = 6000$ watts. With the same load at 240 volts, the current would be $6000 \div 240 = 25$ amp., or one-half that for the lower voltage. Hence, the same percentage drop can be allowed for the higher voltage; that is, if 1.2 volts are allowed in the first case, 2.4 in the second will give satisfactory operation. From the chart it will be found that the size of wire required is No. 5. For 120 volts, therefore, No. 00 wire having 133,100 circ.mils is required, and for 240 volts to transmit the same power, only 33,100 circ.mils, or ¼ the size. No. 5 wire is a size not ordinarily used, so that No. 4 would probably be employed, but the saving due to the higher voltage is apparent.

If the load consists entirely of incandescent lamps the current can be determined either by dividing the total watts on the feeder by the voltage of the lamps or by multiplying the current per lamp (see Table 1, page 602, May 4 issue) by the number of lamps. With arc lamps it is best to multiply the current taken by each lamp by the number of lamps. For alternating-current circuits, the same chart may be used if the two wires of a circuit are run in the same conduit and the load consists of incandescent lamps. Alternating-current arc lamps have a power factor of about 0.70 or 0.65, and if a large load of these were to be carried on a feeder the drop would be greater than for direct-current and the method employed for calculating motor circuits, as described later, should be used. For wires not larger than No. 4 the chart can be used without modification for circuits carrying alternating-current arc lamps. For exposed work, where the wires are separated several inches, the drop on the circuits would be greater than for direct current. In the case of branch circuits No. 10 or smaller, the increased drop is small even with arc lamps; consequently, the direct-current chart can be used. For the feeders, however, the drop should be calculated by the method used for motor circuits. If a feeder carries both arc and incandescent lamps, it is not correct to add the two circuits together. This is because of the power factor.

Branch Circuits

The wiring of an electric-light installation is divided into branch circuits, to which the individual lights are connected, and the feeders which supply the branches.

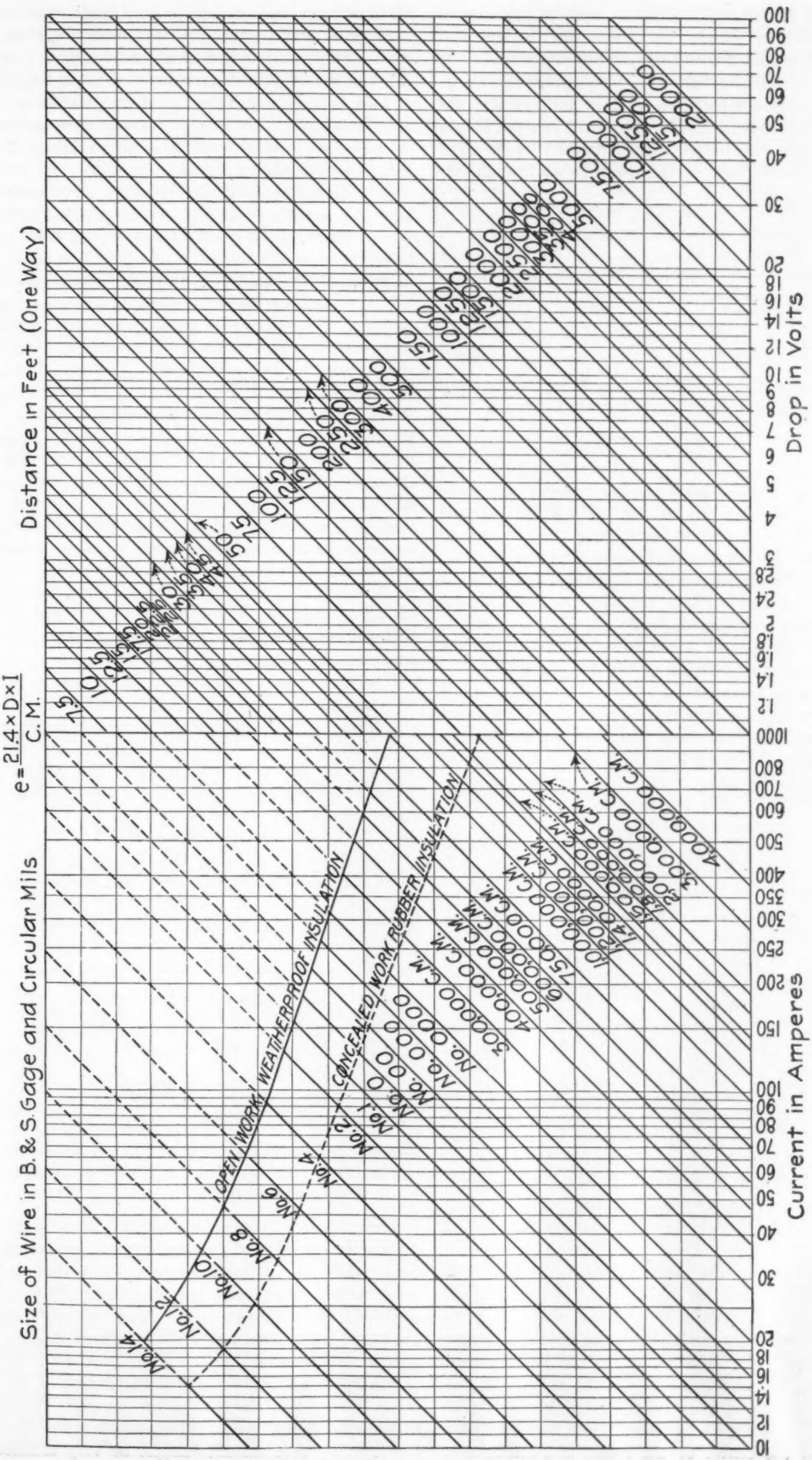


FIG. 7. STOVEL-CABLE WIRING CHART FOR DIRECT-CURRENT CIRCUITS

Sometimes, a feeder supplies more than one group of branch circuits, in which case there are feeders and sub-feeders, or mains, feeding the individual groups. The arrangement of circuits varies to suit conditions. Fig. 8-a shows a scheme sometimes used in mills where the cost must be kept down. Here, mains are run the length of the room and the lights tapped directly from them through individual fuses in the rosettes, no branch cir-

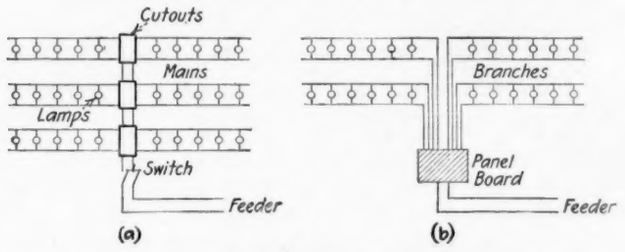


FIG. 8. ARRANGEMENT OF BRANCH CIRCUITS

cuits being used. Its principal objections are lack of control of the individual circuits and variation in voltage at the lights, as those nearest the fuse blocks may have a voltage 2 or 3 per cent. higher than those at the extreme end. A modification of this arrangement is shown in Fig. 8-b. Here the lamps are arranged in groups taking not more than 660 or 1320 watts, depending on the kind of outlet, and each group is wired separately to a panel-board. This has the advantage of individual control of the groups of lamps and while more expensive is used extensively, particularly with large-sized lighting units.

Fig. 9 shows an arrangement frequently used for small office buildings and sometimes for factories. Here there is a panel-board on each floor, from which the branch circuits are run. This has some of the objections found in Fig. 8-a since the drop to the panel on the top floor will be greater than that to the first floor. However, it is fairly satisfactory for buildings of four stories or less, particularly if the load on each panel is relatively small. In Fig. 10 is shown a modification of this arrangement which results in much better voltage regulation, since the drop to each panel can be made about the same. A further modification would provide one feeder for each panel, but this is justified only when the load on the panel is very large. As a rule, not more than three panels should be placed on one feeder.

It is assumed that the number, size and location of the outlets have been settled as previously described. If control switches are to be provided, they should be located carefully. For offices and similar places they should be placed about 4 ft. from the floor, near the entrance door on the lock side, so as not to be hidden when the door is open. In factories they may be located on columns or side walls and should be grouped as much as possible, to save wiring. When the tenants are supplied with meters they should be placed near the panel-board if possible, or in the various offices. Meters are not commonly used, owing to the cost, the usual method being to charge each tenant a flat rate for lighting. The panel-board should be as near the center of the load which it is to supply as possible, as this results in more uniform voltage on all the lamps. For office buildings the best location is in the halls, the panels being, as far as possible, at corresponding points on the various floors, so as to give direct vertical runs for the feeders. For factories they should be near the center of the room, if feasible, and for very large areas the room may be divided into two or more parts and a panel provided near the center of each part. The number and location of panels are fixed by the number of branch circuits and their lengths. It is unwise to use long branch circuits because of the high drop, and for uniformity in wiring it is generally best to settle on one size of wire for all branch circuits irrespective of their lengths.

As a guide in locating the panel, it is convenient to know the length of branch which can be used and not exceed 1.5 per cent. drop. Table 8 gives these values for the sizes of wire ordinarily used for branches, with the maximum load allowable and also with smaller loads. When using this table the distance given is that to the center of the load. For example, if there were 8 outlets of equal size and spaced 10 ft. apart, the center of load would be at the center of the row; that is, a distance of 35 ft. from one end. If from the panel to the first lamp were 20 ft., the distance to be used in calculating the drop would be 55 ft., and it would be assumed that the entire load on the branch was to be carried to that distance. If the units are not all the same size the center of load would shift toward the larger ones. To calculate the center of load in this case multiply the distance from each unit to the panel-board by the number of watts or amperes for that unit, add these values together and divide by the total watts or amperes in the circuit; the result will be the distance to the center of load. With the aid of this table the location of the panel-board may be roughly checked.

The maximum load in watts which may be carried by one branch has already been specified, but it is also necessary to check the number of sockets on each branch. For a 660-watt branch not more than 16 will be allowed, and for a 1320-watt branch 32 is the largest number. These rules apply to the circuits where the lamps do not have individual fuses, but only fuses for the entire group on one branch. These rules would allow the use of sixteen 40-watt lamps in the first case, and thirty-two in the second. Since the lamps are usually larger than this, the number of outlets would generally be less. Sometimes local rules modify these general rules, so it

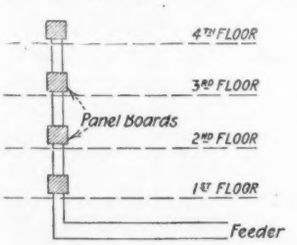


FIG. 9. ARRANGEMENT FOR SMALL OFFICE BUILDINGS AND FACTORIES

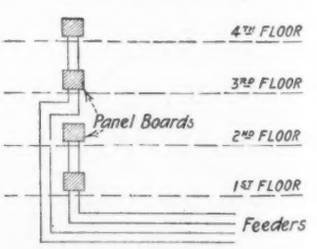


FIG. 10 DROP TO EACH PANEL ABOUT THE SAME

is always best to obtain information on this point from all parties interested. In counting the number of sockets, plug outlets for portable lamps must be included. It is important to have each branch circuit fully loaded, as each additional branch which must be provided for on the panel-board makes an additional cost of three or four dollars in the panel; on the other hand, it is frequently necessary to allow for possible extensions of the branch or an increase in the size of the lamps. The extent of this allowance will vary. Thus, an office building, where the lighting requirements might be very different with

different tenants, should be more liberally designed than factory lighting, where the requirements are fairly well fixed. For the latter the branches may be loaded to 90 per cent. or more of their capacity, while for the former it is best to allow only 80 to 90 per cent. load.

After the branches have been sketched in, the size of wire should be determined. It is common to use No. 14 for branches, but reference to Table 8 will show that the lengths must be rather short if the allowable drop of 1.5 per cent. is not exceeded. For the usual runs in factories and office buildings No. 12 wire will be found more suitable; and for circuits with 1320 watts, No. 10 may have to be used. It is unnecessary to check all the branch

TABLE 8—BRANCH LIGHTING CIRCUITS

Maximum length of circuit for 1.5 per cent. drop.

Size, B. & S. Gage	Distances in Feet*: 120 Volts 12 Amp.	10 Amp.	6 Amp.	5 Amp.	240 Volts 6 Amp.	5 Amp.	3 Amp.	2.5 Amp.
14	29	35	58	70	116	138	232	276
12	46	55	92	110	184	220	360	440
10	73	87	146	174	292	348	...	...
8	116	139	232	278	464	...	...	...

*Note that the distance given is in each case to the center of load and not to the end of the run.

circuits; one or two from each panel, which appear to have the greatest drop, being checked by means of the chart or Table 8. If it is found that the allowable drop is greatly exceeded, a larger wire may be used or a rearrangement of circuits made. If this load is decreased, the number of circuits will be increased, and thus affect the cost of the panel. Therefore, it will generally be preferable to increase the size of wire. In any case the branch circuit should be fused to its maximum capacity as follows:

	125 Volts or Less	125 to 250 Volts
660-watt circuit.....	10 amperes	5 amperes
1320-watt circuit.....	20 amperes	10 amperes

Referring to the example given in Table 3 (see page 604, May 4 issue), let us apply these rules to the machine-shop floor. The natural location of the panel would be on one of the columns on the center-line of the room. The column nearest the center would have four bays on one side and five on the other, giving a maximum length of branch circuit of about 112 ft. In this case, it would be best to run the circuit with the length of the room, to facilitate the control, although this

TABLE 9—LOADS ON PANELS

Floor	A Panel No.	B Circuits in Use	C Total Circuits Provided	D Load in Watts	E Amperes Load at 120 Volts	F Maximum Amperes
Basement .	1	4	6	2,160	18	30
First floor.	2	12	16	10,800	90	160
Second floor	2	12	16	10,800	90	160
Third floor.	4	8	10	3,600	30	50
Fourth floor	5	12	16	10,800	90	160
Fifth floor.	6	12	16	10,800	90	160

compels crossing the beams forming the bays. There would be a maximum of 10 lamps in one row on one side of the panel-board, the distance to the first unit on the farthest row being about 35 ft. and that between end units 67.5 ft.; hence, the distance to the center of the load is $\frac{67.5}{2} + 35 = 68$ ft. 9 in. The load is $\frac{10 \times 100}{120} = 8.3$ amp.

A No. 12 wire, carrying this load, would give a drop of 1.83 volts, or 1.53 per cent., which is satisfactory. The loads on the panels can now be obtained by adding those on each branch, each plug outlet for a portable light being figured at 50 watts. The size of the panels will be fixed by the number of circuits, plus an allowance for extensions. For panels up to 10 circuits, at least 2 spare circuits should be allowed and for 10 to 20 circuits at least 4 should be provided. These computations, for the example previously discussed, are given in Table 9.

When locating the service connection, or switchboard, care should be taken to place it as nearly central to the load as possible. There is generally little choice, since the board must be located in the basement if the service is underground, and if overhead it must be as close as possible to the point of entrance of the wires. If the supply is from a private power plant the choice of location is influenced by other considerations. The place chosen in any case should be as clean and dry as possible, and provision should be made for preventing access to the board by unauthorized persons.

Feeder Systems

After determining the loads on the panels, it is necessary to plan the feeder system according to the schemes

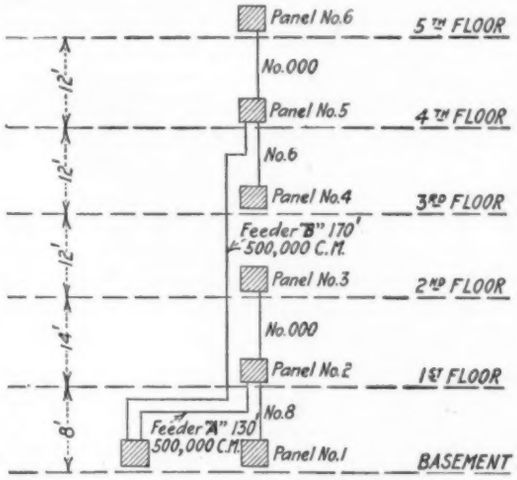


Fig. 11. Riser Diagrams for Factory Building

shown in Figs. 8, 9 or 10. An arrangement similar to Fig. 10 is convenient where it is desirable to provide for cutting off the power from certain sections without interfering with the rest of the lighting. For economy it is desirable to have the load on each feeder as great as possible, but there is a limit to the size of conductor which should be used, particularly where two or three wires are carried in one conduit. For office buildings, particularly, it is difficult to conceal a conduit larger than 2½ in. and to take care of the long-radius bends required for larger conduit. In general, a wire larger than 500,000 circ.mils should not be used. For the system shown in Fig. 9, however, the size may run larger than this, particularly for a two-wire 120-volt system. The feeder system should be planned in a preliminary way, bearing these general statements in mind, a sketch being made showing each panel-board with its load in amperes and the various feeders with their lengths and loads. The load on the feeder should be taken as the total load actually connected to the panels supplied by that feeder. For the example given in Table 9, the actual load in watts is given in column D and the load in amperes is calculated for 120 volts using a two-wire system. Fig. 11 shows the arrangement of feeders supplying the panels.

A reasonable allowance should be made for extensions and for an increase in the lighting load. In any case, the feeder should be sufficient to allow at least 600 watts per branch, or, if the arrangement is such that the larger

branches are used 1200 watts per branch may be allowed; this should include the spare circuits. The feeder chosen should then be checked to see that the drop, with the actual load, does not exceed the allowable amount as specified previously. If the drop is too great the feeder must be increased in size.

Column F in Table 9 gives the maximum loads for the example chosen. Referring to Fig. 11, calculate the size of feeder *B*. The length is 170 ft., the maximum load 370 amp. and the actual load 210 amp. This requires a 500,000-circ.mil cable if rubber wire is used. The drop with 210 amp. would be 1.53 volts. The maximum allowable drop, as previously specified, is 1.3 per cent. for a feeder. This is 1.56 volts for a 120-volt system; hence, the size of cable chosen is satisfactory. In this case, since the subfeeders supplying panels 4 and 6 are short, practically all the drop is in the feeder and 2 per cent. could be allowed if necessary. If the drop in the branches is less than 1.5 per cent. it is not satisfactory to add the amount saved in the branch circuit to

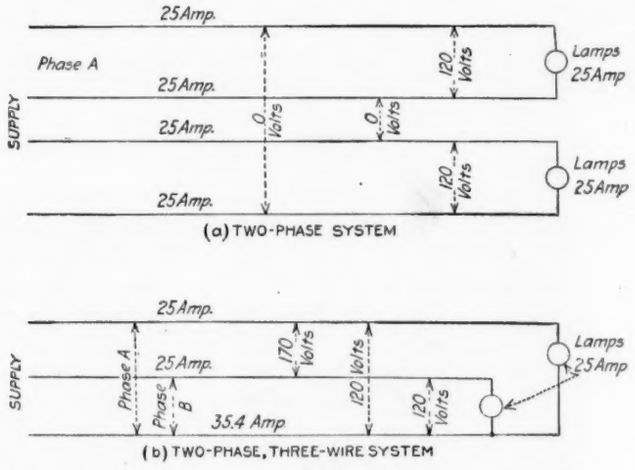


FIG. 12. CURRENT AND VOLTAGE RELATIONS IN TWO-PHASE SYSTEM

the feeder drop, thus making it more than 2 per cent.; instead it should be kept within this limit.

If the total feeder drop exceeds a proper value it must be decreased by increasing the size of feeder or subfeeder. Generally, it is best to increase the main feeder leading to the first panel, as the drop on the subfeeders running to the other panels is usually small. The drop in the subfeeders should be about 0.7 per cent. and in the main feeder 1.3 per cent. When more than one panel-board is carried on a feeder, as in Fig. 10, the subfeeders will be smaller than the main feeders, and would therefore not be protected by the fuses on the latter. To protect these subfeeders, the panel is provided with the necessary fused branch circuits to which they may be connected, these circuits being connected to the main feeder where it enters the panel. With the arrangement of Fig. 9, the size of feeder would be decreased for the panels on the lower floors, the feeder entering the panel-board at the bottom and leaving at the top, and fuses must be provided at the top to protect the subfeeder above. The panel busbars must be large enough to carry the entire current of the panel and the subfeeders connected to it. When the sizes of wires have been checked, the sizes of conduit can be determined by means of Table 6 (see page 641, May 11 issue), bearing in mind that both wires of a circuit must be in the same conduit if alternating current is used.

THREE-WIRE SYSTEM

Calculation of a three-wire system is much the same as that of a two-wire, so that only the points of difference will be discussed. As long as the load is the same on each side of the system there will be no current in the neutral. If, however, the load on the positive side were 20 amp. and on the negative 25, there would be 5 amp. in the neutral. If all the load were removed from the positive side, the current in the neutral would be the same as in the negative wire. Since there is always a chance of the load being different on two sides of a three-wire system, the neutral must be sufficiently large to carry the difference, and is generally made the same size as the outside wires. This is not required by the "National Electric Code," except in certain cases, but it is good practice. If the neutral circuit is opened when the load on each side is the same, there will be no change in the voltage across each group of lamps; but if the negative side, for example, has a larger load than the positive, the lamps on the former would receive less than 120 volts and those on the latter more; hence, these lamps might burn out. Such a case might occur if a fuse in the neutral should blow.

The location of outlets would be the same as for the two-wire system, since the branch circuits are two-wire in any case. The location of panel-boards and switchboards is determined in the same manner, and the arrangement of the circuits may be similar to those shown in Figs. 8, 9 or 10, using three-wire mains and feeders instead of two-wire. The layout of the branch circuits would be made in the manner previously described, and the drop would be limited to about 1.8 volts, since 120 is the voltage for the branches. The branch circuits are so connected to the panels as to give practically half the total load on each side; in other words, to produce a balanced system. The actual load in each outside wire of the feeder would, therefore, be one-half the total for all the lamps supplied from that panel.

The determination of the feeder sizes is governed by the same rules as for the two-wire system. The actual loads in the outside wires would be the sum of the loads for all the panels supplied by that feeder. The maximum load should also be determined by allowing 5 or 10 amp. for each branch connected to either side of the circuit. When these loads have been determined for each main feeder and subfeeder, the size of wire may be chosen by means of Table 7 (see page 642, May 11 issue), using the maximum loads as before. The feeders should then be checked for voltage drop with the actual load. The voltage loss allowable in the feeders is 2 per cent. of the voltage to the neutral, for each side of the system. Thus, if a 120-240 volt system is used the drop for each side of the system may be 2.4 volts. With a balanced load, all of this occurs in the outside wires. If the load were unbalanced, there would be some drop in the neutral, but in any well-designed system this is so small that it may be neglected.

Care should be taken when using the chart, since it gives the drop for a length of wire twice that marked on the various lines, which is the length of run. If the current in the outside wire of a two-wire feeder is used, and the length taken is that for the feeder, then the voltage drop

obtained by the chart should be divided by 2 to obtain the drop in a single wire. After the sizes of the outside wires have been determined the neutral may be taken the same, and then the conduit sizes are determined, using one conduit for all three wires if alternating-current is employed.

Referring to the previous example, feeder B would have a maximum load of 185 amp. and an actual load of 105. A drop not exceeding 2.4 volts can be allowed in each of the outside wires, and to carry 185 amp., No. 0000 cable must be used. The drop on a two-wire circuit having a length of run of 170 ft. is 1.8 volts; hence, that for 170 ft. of wire is 0.9 volt, and this is the drop on each of the outside wires of feeder B. The actual voltage loss on the lamps, however, is only 0.9 volt, since they are affected only by the drop in the wires to which they are connected.

Sometimes a three-wire system is arranged so that it can be changed to a two-wire by connecting the outside wires together at the switchboard. This transforms it into a 120-volt two-wire system. If this is to be done, each side should be calculated as a two-wire system with one-half load, the outside wires being made of the size thus determined and the neutral double this size. Sometimes, this type of system is calculated as a three-wire, and then the neutral is made twice the size of the outside wires, but this arrangement results in a higher drop at the lamps than when it is run as a three-wire system.

Three-Phase System

Three-phase systems are sometimes used for lighting, but should be avoided for such service if possible. The three-phase system with three wires takes considerably more copper than the three-wire system, while the four-wire arrangement saves in copper at the expense of added complication in the panel-boards. The branch circuits would be two-wire, as in the previous arrangements.

After the sizes of feeders have been determined from Table 7 by using the maximum load, the drop should be checked by means of the chart. Allowing 2 per cent. drop, this amounts to 2.4 volts across the lamps for a 120-volt system. The allowable drop for each wire is 0.58 times 2.4 volts, or 1.39, and the size should be determined, using the actual load previously found. In using the chart it should be remembered that it gives a drop for a two-wire circuit, so the voltage drop obtained should be divided by 2. The chart can be used if the three wires of a feeder are all in the same conduit; if not, other methods to be described later may have to be used. If the three-phase four-wire system is used, the branch circuits would be divided into three equal parts as before, and connected between the three main wires and a common wire called the neutral. The current in each of the main wires would be the total for all the lamps connected to that wire, and that in the neutral would be zero as long as the current in all the main wires was the same. The actual and maximum currents would be determined as before, using the branches connected to one of the outside wires. If the allowable drop in the feeders is 2 per cent., this applies to each main wire, so the drop in each of these wires for 120 volts across the lamps would be 4.8 volts. The wire size can be obtained in the same manner as before and the neutral made the same size as the other wires.

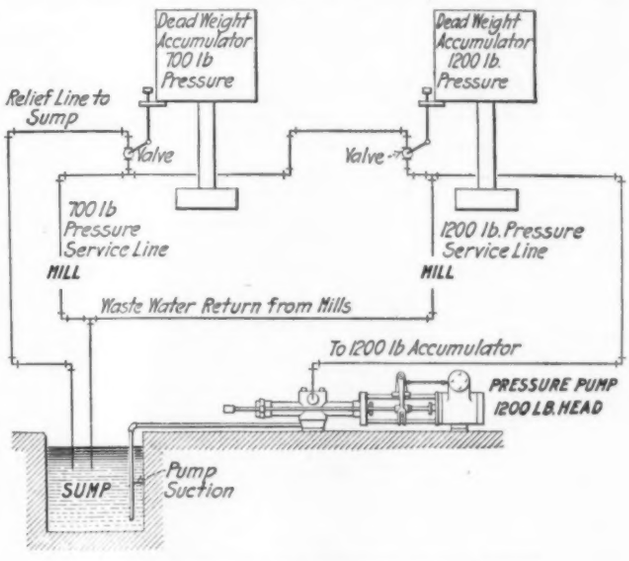
The two-phase system, for use in lighting, is open to the same objections as the three-phase, if all the feeders and subfeeders are made two-phase. Either of the plans shown in Fig. 12 may be used. If the arrangement in *a* is used each phase can be treated independently and figured as a simple two-wire system, but with arrangement *b*, the current in the common wire is obtained by adding together the currents in the two outside wires and multiplying by 0.71. When the load is practically the same on each side, the voltage drop can be computed readily. First calculate the drop in either outside wire with the current previously determined, then the drop in the common wire which would be caused by this same current. Add these together and let the result be represented by A. Then calculate the drop in the common wire due to the current from the other outside wire, and let this be B. The total drop is $\sqrt{A^2 + B^2}$.

In general, the three-phase or the two-phase systems are not well adapted for interior wiring. If either of these systems must be depended upon as a source of supply, it is better to arrange the circuits as a single phase, two-wire or three-wire system.

Two-Pressure Hydraulic Service

By A. D. Williams

Manufacturing operations at the plant of the Firestone Rubber Co., Akron, Ohio, require pressure water at 700 and 1200 lb. per sq.in., and the method adopted to obtain this service is shown in the illustration. Two dead-weight loaded accumulators are used, and the pumping plant is



Arrangement of Accumulator Piping

designed to deliver to the higher-pressure accumulator and to hold it at the highest point of the stroke, delivering water to supply the demand for both pressures. As soon as the high-pressure accumulator rises its full height it opens a valve and a portion of the water flows to the low-pressure accumulator and this, when it reaches the top of its stroke, opens a relief valve, permitting the surplus water to return to the sump or sewer.

To prevent excessive waste of pressure water the steam supply to the pressure pumps is shut off automatically when the low-pressure accumulator rises to a sufficient height to open the relief valve. The pumps are automatically started when either the low- or high-pressure accumula-

tor drops a certain amount. The starting device is so arranged that it will act to start the pump if the high-pressure accumulator drops while the low-pressure accumulator still remains at its highest position. This provision is necessary, as the demand for pressure water is variable upon each of the two pressure systems and a heavy demand might be made on the 1200-lb. line at a time of no demand on the 700-lb. line. In practice the arrangement works out nicely, maintaining full pressure upon both lines and taking care of all service demands.

Pressure water is supplied to the system by three pumps. One is a 13&26x4½x24-in. outside-packed plunger pump with a Corliss cross-compound steam end and flywheel. At present this machine is operating noncondensing, but later is to be connected to a condenser. It will deliver 300 gal. per min. at 50 r.p.m. There are two duplex-compound outside-packed plunger pumps, 12&18x5¾x16 in. These comprised the first hydraulic-service installation, the flywheel pump having been added within the year.

Internal-Combustion Engine Dimensions

By H. L. Watson

SYNOPSIS—A chart for graphically determining the speed, bore and stroke for a given type and size of internal-combustion engine according to average American practice.

During the summer of 1912 there appeared in Power a series of articles by Messrs. Ulbricht and Torrance upon "American Practice in Rating Internal-Combustion Engines."* These represented the results of an extensive thesis made at Cornell University under the direction of Professors Diederich and Hirshfeld, the data being given in the form of curves from which empirical equations were obtained. By means of these equations it is possible to determine the cylinder bore, stroke and revolutions per minute necessary for an engine of any desired type, fuel, and power; four-stroke-cycle stationary engines only being considered. These equations are given in Tables 1 and 2.

It occurred to the writer that these equations might be plotted upon one sheet, thus reducing the work necessary for the solution of a problem. Upon such a chart, herewith shown, all curves denoted by letters refer to the type of engine, and those denoted by Roman numerals refer to the fuel used. To further distinguish them the curves are represented by different kinds of lines.

TABLE 1

Relation of d^2ln and b.hp. for Various Fuels	Remarks
Producer gas $d^2ln = 18{,}500$ (b.hp. + 2) $d^2ln = 17{,}900$ (b.hp. + 1) $d^2ln = 20{,}600$ (b.hp. + 4)	Average—all values. Single-acting—horizontal and vertical Double-acting—horizontal
Natural gas $d^2ln = 15{,}200$ (b.hp. + 5)	Average—all arrangements
Illuminating gas $d^2ln = 15{,}700$ (b.hp. + 2)	Single-acting—horizontal and vertical
Blast-Furnace Gas $d^2ln = 21{,}000$ (b.hp. + 5)	Double-acting—horizontal
Oils and distillates $d^2ln = 21{,}875$ (b.hp. + 0.75)	Single-acting—horizontal and vertical
Gasoline $d^2ln = 16{,}400$ (b.hp.) + 0.5)	Single-acting—horizontal and vertical

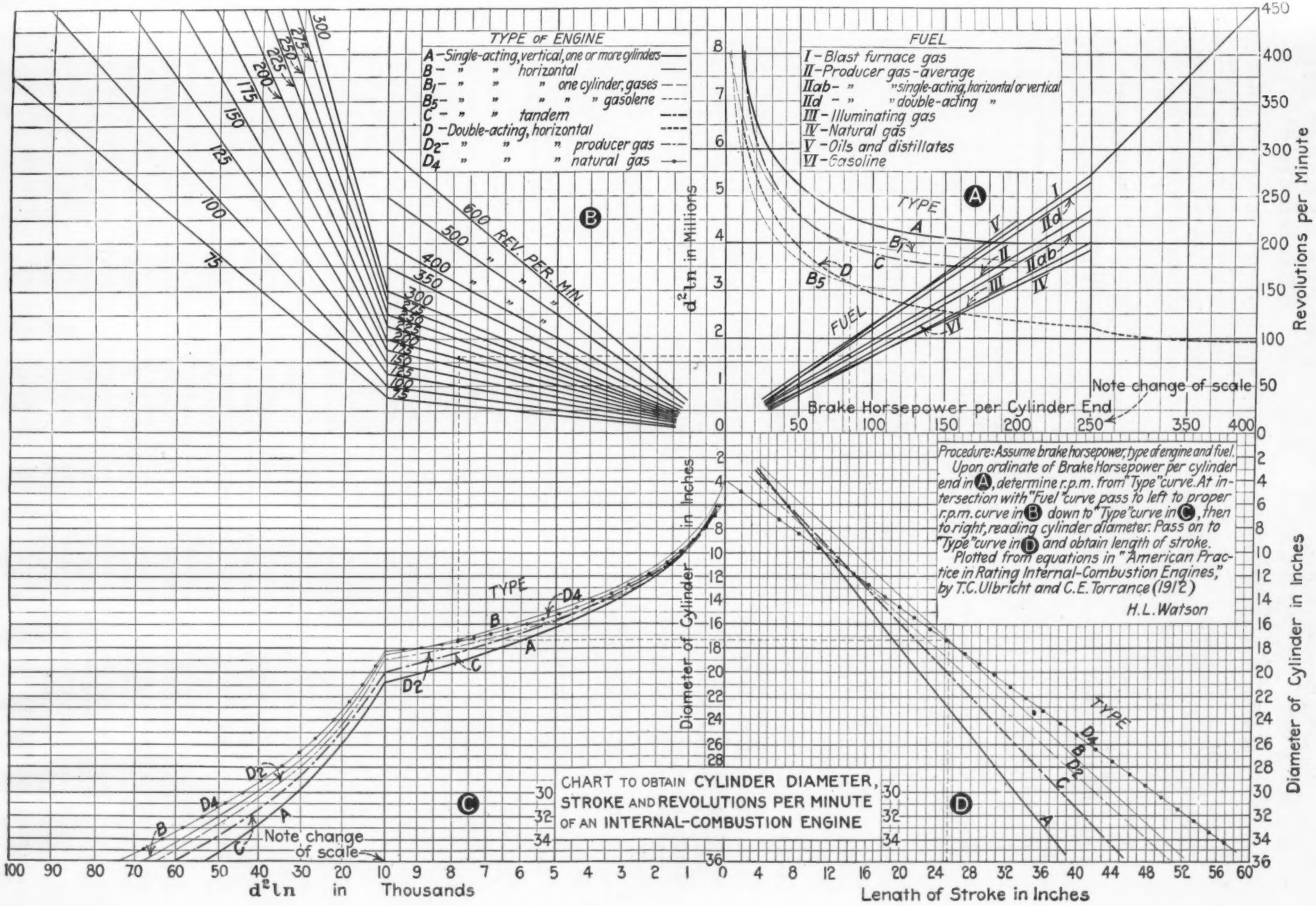
TABLE 2

Type of Engine	Relation of n to b.hp.	Relation of d to l	Relation of d to d^2l
Vertical Single-acting	$n = \frac{5368}{b.hp. + 14} + 176$	$d = 0.91\,(l) - 0.45$	$d^3 + 0.45d^2 = 0.91\,(d^2l)$
Horizontal single-cylinder Single-acting	Gasoline $n = \frac{3020}{b.hp. + 9} + 128$ Gases $n = \frac{6580}{b.hp. + 21} + 131$	$d = 0.667\,(l) + 0.4$	$d^3 - 0.4d^2 = 0.667\,(d^2l)$
Horizontal tandem Single-acting	$n = \frac{3650}{b.hp. + 4.5} + 156$	$d = 0.772\,(l) + 0.55$	$d^3 - 0.55d^2 = 0.772\,(d^2l)$
Horizontal Double-acting	$n = \frac{9500}{b.hp. + 29} + 72$	Natural Gas $d = 0.533\,(l) + 4$ Producer Gas $d = 0.667\,(l) + 2$	Natural Gas $d^3 - 4d^2 = 0.533\,(d^2l)$ Producer Gas $d^3 - 2d^2 = 0.667\,(d^2l)$

Procedure
1. Assume type of engine, b.hp. and fuel.
2. Obtain (d^2ln) from Table 1.
3. Obtain (n) from Table 2, col. 1.
4. Obtain (d^2l).
5. Obtain (d) from Table 2, col. 3.
6. Obtain (l) from Table 2, col. 2.

In all cases b.hp. = brake horsepower per cylinder end.
d = cylinder diameter in inches.
l = length of stroke in inches.
n = revolutions per minute.

*This series was copyrighted by T. C. Ulbricht and C. E. Torrance.


TYPE OF ENGINE
A – Single-acting, vertical, one or more cylinders
B – " " horizontal
B1 – " " " one cylinder, gases
B5 – " " " " " gasolene
C – " " tandem
D – Double-acting, horizontal
D2 – " " " producer gas
D4 " " " natural gas
FUEL
I – Blast furnace gas
II – Producer gas – average
IIab – " "single-acting, horizontal or vertical
IId – " " double-acting "
III – Illuminating gas
IV – Natural gas
V – Oils and distillates
VI – Gasoline
600 REV. PER. MIN.
500 " " "
400 " " "
d²ln in Millions
Revolutions per Minute
Brake Horsepower per Cylinder End
Note change of scale
Procedure: Assume brake horsepower, type of engine and fuel. Upon ordinate of Brake Horsepower per cylinder end in A, determine r.p.m. from "Type" curve. At intersection with "Fuel" curve pass to left to proper r.p.m. curve in B down to "Type" curve in C, then to right, reading cylinder diameter. Pass on to "Type" curve in D and obtain length of stroke.
Plotted from equations in "American Practice in Rating Internal-Combustion Engines," by T.C. Ulbricht and C.E. Torrance (1912)
H.L. Watson
Diameter of Cylinder in Inches
d²ln in Thousands
Note change of scale
Length of Stroke in Inches
CHART TO OBTAIN CYLINDER DIAMETER, STROKE AND REVOLUTIONS PER MINUTE OF AN INTERNAL-COMBUSTION ENGINE

The expression giving the power of an engine per cylinder end is

$$B.hp. = \frac{PLAN}{33{,}000 \times mechanical\ efficiency}$$

where

P = Mean effective pressure;
L = Stroke in feet;
A = Cross-sectional area of cylinder in square inches;
N = Number of explosions in that cylinder end per minute.

It may thus be said that the power is a function of d^2ln,

where

d = Diameter of cylinder in inches;
l = Stroke in inches;
n = Revolutions per minute.

The equations of the relations between b.hp. per cylinder end and d^2ln for different fuels have been replotted in the upper right-hand section of the chart. The curves between brake horsepower and revolutions per minute for engines of different types have also been plotted in this section, while those showing the relations between bore and stroke for engines of different types have been replotted in section D.

It was necessary to plot curves giving the relations between d^2ln and d. This was done by first drawing in section B a series of curves between d^2ln and d^2l for various r.p.m., and then plotting in section C curves showing the relations between d^2l and d for the different types of engines. The equations of these latter curves were determined as follows:

From Table 2, col. 2 (for a vertical, single-acting engine)

$$d = 0.91\,l - 0.45, \text{ or } l = \frac{d + 0.45}{0.91}$$

whence

$$d^2l = \frac{d^3 + 0.45\,d^2}{0.91}$$

Proceeding in the same manner with the remaining types of engines, the set of equations in column 3 was obtained.

The use of this chart is best illustrated by an example. Let it be desired to determine the revolutions per minute, stroke and bore for a single-acting, horizontal, single-cylinder engine using producer gas and developing 85 b.hp. per cylinder end.

First note the legends in the chart for the curves corresponding to the type of engine and fuel assumed. Upon the 85-b.hp. ordinate in section A note the intersection with the "type" curve, B_1, giving (to the right) the r.p.m. as 200. From the intersection of this same ordinate with the "fuel" curve, II_{ab}, pass horizontally to the left to the intersection with the line in section B representing 200 r.p.m., thence downward to the curve B in section C; from this point pass horizontally to the right, finding the bore of the cylinder to be 17¼ in. By proceeding further to the right to the intersection with curve B in section D, we will find the stroke of the engine to be approximately 25½ in.

It must be remembered that these curves have been drawn through many values plotted and, as such, represent the average size and speed for an engine of the type and power desired, built according to American practice, as set forth in the original article.

Franklin Cylinder Oil "Carburetor"

Engineers have learned by experience that if cylinder oil is fed through a pipe connection that just passes through the shell of a steam pipe, the oil is not well distributed in the engine cylinder to which the pipe is connected. A number of atomizing devices have been

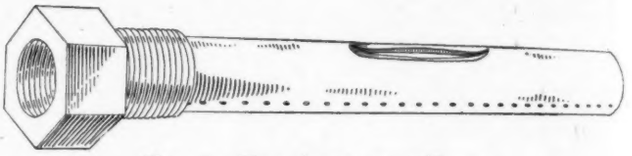


FIG. 1. THE ATOMIZING TUBE

used, such as perforated pipes that extend part way across the inside of the steam pipe.

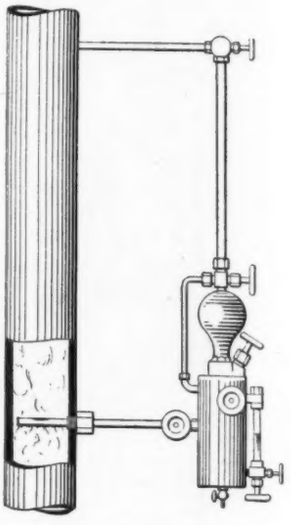


FIG. 2. "CARBURETOR" AS USED WITH A LUBRICATOR

What is known as the Franklin oil "carburetor" is made by the Franklin Oil & Gas Co., Bedford, Ohio. It is designed to atomize the oil so that it will mix with the steam before it enters the cylinder.

The device is made with a nut having a threaded shank with a hollow tube extension that is plugged at the inner end. The top of the tube is slotted and two rows of small holes are drilled in the tubes about one-quarter way around from each side of the top slot. Holes are also drilled in the plugged end. The heated, atomized oil is discharged through the holes. Fig. 1 illustrates the idea.

The "carburetor" is screwed into the steam pipe with the slotted side up when at its permanent position. The lubricator or forced feed pump discharge pipe is screwed to the thread inside the nut which is outside of the steam pipe, Fig. 2. The appliance is made in three sizes—⅜-, ½- and ¾-in. standard pipe threads, and of different lengths to meet the requirements of the steam-line diameter.

Branded Waste

While waste is one of the minor items of power-plant supply, a saving of any considerable percentage of the aggregate amount spent for this commodity in one year would be a very tidy sum. The Royal Manufacturing Co., of Rahway, N. J., extensive dealer in cotton and woolen waste, is making an attempt to standardize the trade. It has divided its wares into twelve branded grades, of which samples are furnished in a folder. The waste is bought by its branded name, and the packages are guaranteed to contain not over a certain amount of tare and to be of accurate weight, so that the payment for a lot of hoops and bagging at waste prices, or the padding of an order 30 to 50 per cent., is avoided.

The Why's of Boiler Draft

By C. F. Hirshfeld*

SYNOPSIS—Draft through a boiler simply explained by comparison with a pipe carrying water under pressure. The stack is considered as a pump and its action explained from this viewpoint.

Despite the fact that much has been written on the subject of draft and its significance in boiler practice, there seem to be many engineers to whom it is more or less mysterious. One of the simplest methods of attacking this problem and one which has the advantage of giving correct viewpoints throughout is to compare the boiler passes, flues and other parts with a pipe or conduit carrying water under pressure.

Measuring Head by Standpipe or Gage

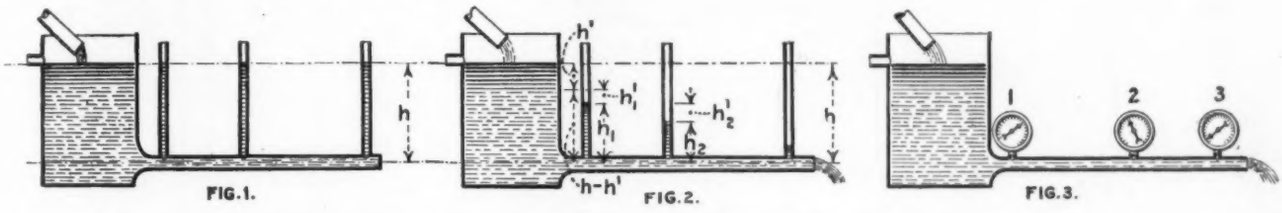
Assume for this purpose the arrangement shown in Fig. 1. A large vessel is fitted with an overflow, and water is supplied constantly through the nozzle shown. If the overflow is large enough, the height of water will remain constant at the level shown. The pipe leading from the bottom of the vessel will, for the time being, be assumed closed at the right-hand end. Under such conditions, the pipe will stand full of water under a head h. If holes are drilled in the horizontal pipe and fitted with standpipes, as shown, the water will rise in each standpipe to the same height as that in the main vessel.

If the end of the horizontal pipe is opened so that a steady flow of water can occur, the water in the vertical pipes stands at successively lower heights as the open end of the pipe is approached. This is shown in Fig. 2. The explanation, as commonly expressed, is that part of the head is used up in overcoming frictional and similar resistances to flow. It is obvious that dynamic conditions (flow occurring) and static conditions (no flow) are different.

Analyzing the case shown in Fig. 2 more closely, the most obvious difference between it and that shown in Fig. 1 is the fact that the water in the former is moving. As water possesses mass, energy is required to give it motion, and this energy can be measured in terms of a head of water. Thus, in the case of Fig. 2 the required head might be that shown by the height h'. This much of the total head h would be used in the large vessel for imparting velocity to the water. The water flowing out of the large vessel encounters resistance where it enters the pipe, and a part of the remaining head h-h' is lost or used in overcoming this resistance. After the water has entered the pipe, flow is continuously resisted by the friction of the walls and more of the remaining head is used in overcoming this frictional resistance.

Thus, just before entering the horizontal pipe the head remaining is h-h', but by the time the water reaches the first standpipe the head has been reduced to h_1. The amount h_1' has been used to overcome resistance to entrance to the pipe and resistance to flow through the pipe up to the point of location of the standpipe. The head h_2' is used in overcoming the resistance offered by friction in the stretch of pipe between the first and second standpipes.

The heads of water used in the discussion above are merely measures of pressures, and pressure gages might have been used instead of standpipes for reading the loss of head or pressure along the length of the pipe. This arrangement is shown in Fig. 3. If gages 1 and 2 are located at the points previously occupied by the corresponding standpipes, the difference between the gage readings will be equal to h_2', if converted into feet of water.



Illustrating Reduction of Pressure Due to Resistance to Flow

It should be particularly noted that the pressure on the surface of the water in the larger vessel is atmospheric and also that the pressure of the water just as it issues from the end of the horizontal pipe is also atmospheric. That means that the total head h must have been used within the system. Part was used in overcoming resistances, the rest in giving the water velocity; the latter part of the head is represented by the velocity with which the jet of water enters the atmosphere.

If difficulty is experienced in recognizing the fact that the pressure of (or on) the issuing jet is atmospheric, it is only necessary to consider what would happen if it were not. If the pressure of water in the jet were greater than that of the atmosphere, the jet would burst or spread laterally as soon as it issued from the confining walls of the pipe. If the pressure of the water were less than atmospheric, the jet would be compressed by the atmosphere to a smaller diameter than that of the inner surface of the pipe.

Showing Variation in Head Graphically

Referring to Fig. 4, with static conditions (discharge end of pipe closed), the pressure throughout the length of the pipe is the same and equal to that caused by the head h plus that caused by the atmosphere on the liquid. This is shown by the line AB at a height above atmospheric pressure equal to a, which represents a pressure equal to that caused by h feet of water. With dynamic conditions, the case is different. The pressure just inside

*Chief of research department of the Edison Illuminating Co. of Detroit.

the entrance of the pipe is shown by the height of A', the distance between A' and A representing the head used in giving the water its velocity and in overcoming resistance to entrance at the inlet. If the pipe is uniform for its length so that the friction loss is the same at all points, the loss of head or pressure will be the same per unit of length at any point along the length and the pressure drop will be as shown by the line $A'B'$. When the end of the pipe is reached, the pressure of the water is equal to that of the atmosphere. This is shown by the location of the point B' on the atmospheric line in Fig. 4.

Pump vs. Pan

For the purpose of getting a case which more nearly parallels the conditions existing in the case of a boiler, the arrangement of apparatus so far considered will be slightly changed. Imagine a vessel connected to a pipe and pump, as shown in Fig. 5. When the pump is not in operation, the water will stand at some height h in the tank and the pipe, and the pressure on the two surfaces of the water will be atmospheric. When the pump is operating, the pipe is filled with water which flows up to the top and into the pump. It is obvious that the water is forced to flow up the pipe by the atmospheric pressure exerted on the surface in the open tank, and if this is true, the pressure within the pipe at the same height must be less than atmospheric. Shown graphically, the case would appear as in Fig. 6. In this figure, the pipe length has been straightened and shown on the horizontal axis as before.

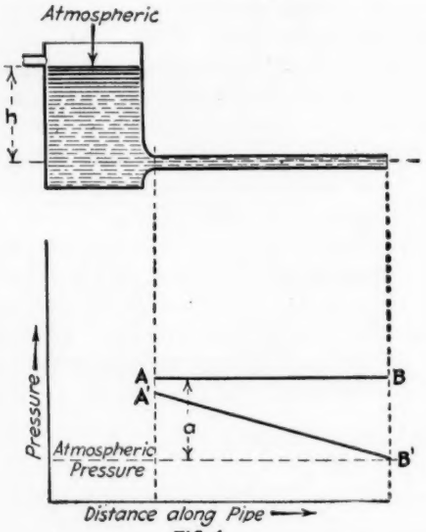


FIG. 4.

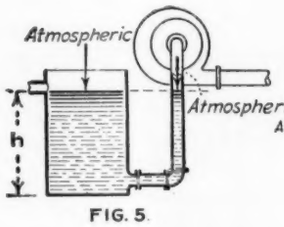


FIG. 5.

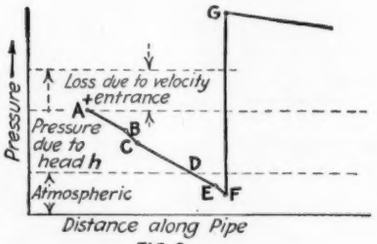


FIG. 6.

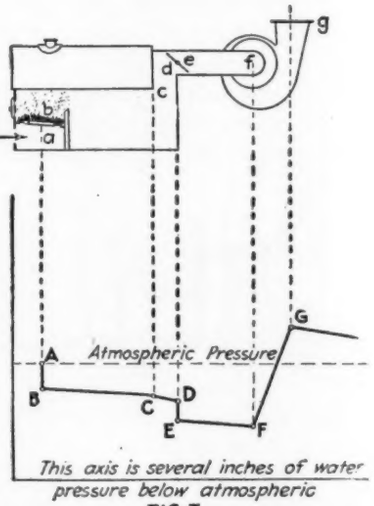


FIG. 7.

Showing How the Action of a Centrifugal Pump Is Like That of a Fan

At the point A in Fig. 6, which represents conditions just inside the entrance to the suction pipe, the pressure is equal to that due to atmospheric plus that due to the head h less that lost by conversion to velocity and by resistance to entrance to the pipe. There is then a gradual drop due to friction along the straight part of the pipe to the point B, which represents conditions at the entrance to lower elbow. The loss through the elbow is greater than through the same length of straight pipe, and there is therefore a more rapid drop of pressure from B to C in passing through the elbow. The line representing loss of pressure or head then runs from C to E, the pressure decreasing both because of vertical rise and friction loss. The drop EF represents the loss caused by the upper elbow and by resistances to entry at the pump, so that the pressure which would be shown by a gage connected to a point inside the eye of the pump impeller would be that indicated at F, and obviously lower than atmospheric. In the pump the pressure is raised from that shown at F to that shown at G and then there is a gradual and regular loss of pressure again because of the frictional resistance offered by the discharge pipe.

This case is practically identical with that of a boiler under induced draft, as shown in a simplified way in Fig. 7. The pressure in the ashpit is that of the atmosphere. The air is started in motion and passes through the grate and fuel bed against a certain frictional resistance, so that there is some such drop as that indicated by AB in getting from beneath the grate to the interior of the combustion chamber. Flow from that point to the damper occurs in comparatively large passages offering small frictional resistance, so that the drop from the combustion chamber to the damper is not great. In the region immediately preceding the damper, the gases pass through two right-angles and the drop is therefore more rapid for a given distance traveled than it is in the straight run preceding. This is shown by the increased angularity of the line CD. As shown, the damper is only partly open and this would cause a throttling loss DE. From this point the losses go on as before until the air finally enters the fan wheel with a pressure as shown by F. In passing through the fan, the pressure is raised to a value above atmospheric as shown by G and the excess above atmospheric is then lost in passing through the stack, so that the gases are discharged from the open end of the stack at atmospheric pressure.

A more complicated case is shown in Fig. 8, for which a horizontal return-tubular boiler with induced draft has been assumed. Capital letters on the graph refer to positions indicated by small letters in the diagram above. Up to the point D, the case is similar to that just discussed. Beyond that point there is a rapid drop due to loss in entering the tubes, a gradual drop due to friction along the length of the tubes and a rapid drop due to losses at the exit from the tubes. This results in giving a pressure such as that shown by E just outside the

tubes in the uptake. From there on the conditions are similar to those previously described.

A more complicated case is illustrated in Fig. 9. A fan draws air from the atmosphere and pumps it into the wind box, raising the pressure from atmospheric to some such value as that shown by A'. The drop through the fuel bed brings the pressure back to atmospheric in the furnace and then the various losses proceed as in previous cases except that the resistance offered by the economizer adds one more complication.

Cases in which induced-draft fans are employed are generally readily understood because it is simple to see that the fan acts as a pump. By lowering the pressure at its own suction it enables the atmosphere to force itself through the boiler and flues toward and into the suction orifice. The fan then raises the pressure of the gases by the amount required to expel them against atmospheric pressure. When a natural-draft stack is substituted for the fan, however, many experience difficulty in appreciating the fact that conditions are not really altered.

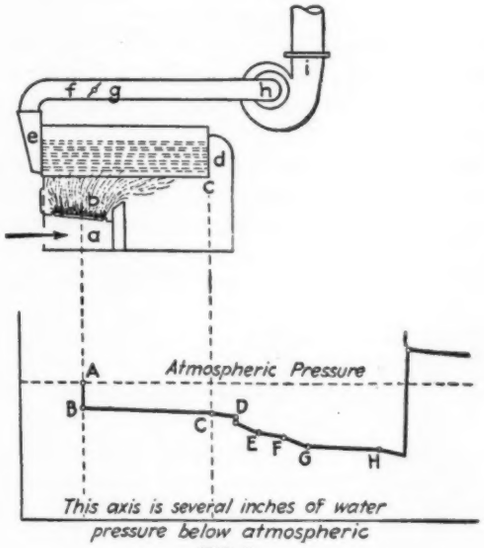


FIG. 8.

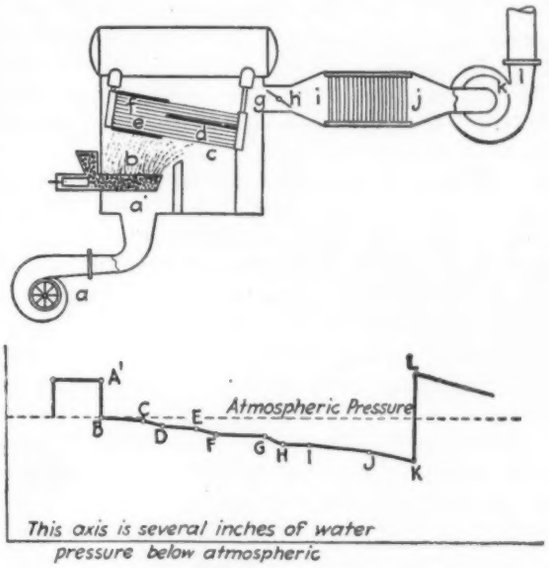


FIG. 9.

DRAFT (PRESSURE) VARIATIONS IN INDUCED- AND FORCED-DRAFT BOILER FURNACES

The stack performs the same functions as a pump in that it lowers the pressure at its suction orifice or base so that air under atmospheric or higher pressure in the ashpit can force itself through the boiler and flues into the suction orifice. The stack then practically raises the pressure of the gases to such an extent that they can be expelled against the pressure of the atmosphere at its top.

ACTION OF STACK

Two simple facts must be realized to understand the action of a stack: First, the pressure of the atmosphere increases as one passes from a high to a low elevation, and, second, the density or weight per cubic foot of any gas decreases if its temperature is raised while it expands to such an extent that its pressure remains constant.

The first of these facts can be forcibly impressed by regarding the atmosphere as made up of a series of layers like a pile of boards, books or blankets. Obviously, if one could weigh all the layers above a point several hundred feet above the earth's surface, they would weigh less than would all the layers above a point at the earth's surface. The weight thus obtained is what is meant by atmospheric pressure. The weight in pounds supported on a surface one square inch in extent is the pressure in pounds per square inch. The pressure of the atmosphere at a height of several hundred feet above the surface of the earth is therefore less than the pressure of the atmosphere at the earth's surface.

The second fact above stated is easily appreciated by taking the following point of view. Imagine a given weight of gas to occupy a certain volume, say one cubic foot at a certain temperature and pressure. If this gas is heated and allowed to expand so as to maintain a constant pressure, the given weight acquires a larger volume, say one and a fraction cubic feet. Obviously, there is not as great a weight in one cubic foot of space at the higher temperature as there was at the lower temperature; that is, the density, or weight per cubic foot, has decreased during heating.

These principles may now be applied to explain the operation of a stack. Imagine a tube to stand vertical on the surface of the earth, as shown in Fig. 10. The pressure at the height of the top is that caused by the atmosphere above that point; it may be represented by p pounds per square inch. The pressure at the earth's surface, inside or outside of the stack, will be greater and may be represented by P. It will be equal to the sum of the pressure p and the pressure p' due to the weight of air between a point at the height of the stack and a point at the surface of the earth.

If a horizontal chamber be built on the side of the tube near the bottom and be separated from the tube by a diaphragm, as shown in Fig. 11(a), the pressure on opposite sides of the diaphragm will be the same and equal to that of the atmosphere at the height d above the surface of the earth. If now, the air in the tube be heated it will expand, and some of it will leave, so that a smaller weight will remain within the tube. The downward pressure p at the top of the tube will be due to the atmosphere above that point and will obviously be the same at any point in a horizontal plane at that height. The pressure at the center of the diaphragm on the outside will be P as before, as shown in Fig. 11 (b). But the pressure on the tube side of the diaphragm will be P' less than P, because

the column of hot air inside the tube weighs less than a column of an equal height of cold air outside of the tube.

If, now, the diaphragm be imagined to be a frictionless and weightless piston, it is obvious that it will move to the right because of the greater pressure on its left-hand side If the lower end of the tube be imagined to be

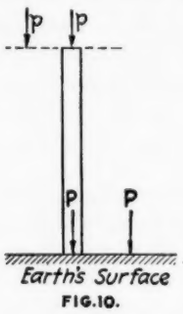


FIG.10.

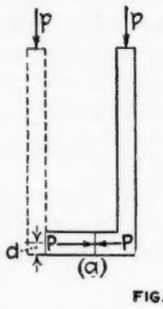


FIG.11.

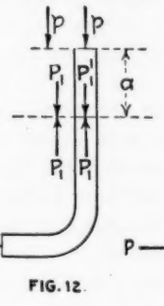


FIG.12.

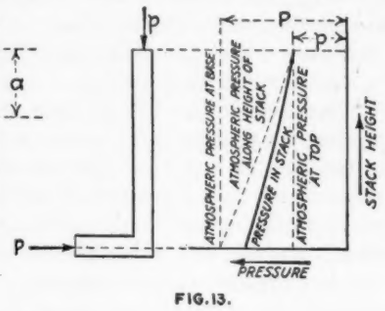


FIG.13.

ILLUSTRATING WHY A STACK CREATES A DRAFT

constructed with an easy bend, the piston would be pushed clear to the top of the tube, because at any lower point the pressure on its lower side would be greater than the pressure on its upper side, as shown in Fig. 12. In this figure P_1' must be less than P_1, because the column of hot air of height a inside the tube weighs less than the column of cold air outside the tube.

A stack or chimney filled with hot air and surrounded with cold air can thus pump the hot air out of itself against the pressure of the atmosphere above. It should be noted in this connection that when the stack is filled with hot gas the pressure within at the base is less than that outside, as shown in connection with Figs. 11(a) and 11(b); that is, the stack "creates a draft." It should also be noted that the pressures outside and inside of the stack are the same at the top, so that the "draft" or "under-pressure" within the stack tapers from a maximum value at the bottom to zero at the top. This is shown diagrammatically in Fig. 13.

It is easy to see that the line representing the pressure within the stack must always lie below (to the right of) the line representing the pressure outside the stack at the same level, from the argument given in connection with Fig. 12. It is also easy to see that it must lie above (to the left of) the line representing atmospheric pressure at the top of the stack, because at any point below the top the pressure inside the stack is equal to the atmospheric pressure above plus that due to the weight of hot air down to the same point.

To convert the model so far considered into an operative stack, it is only necessary to supply a means of continuously heating air as it enters the bottom of the stack, so that the shaft will always be filled with gas at a higher temperature than that outside. This could be done by the use of gas flames playing on the base or by the use of an electrical heater placed within the air at the base. The external cold air would enter at the bottom continuously in an effort to displace the warmer air in the shaft, but as it would be heated as fast as it entered, the process would become nothing more than a gradual sinking of the external atmosphere into the stack and a procession of that same atmosphere up the stack after being heated.

In practice, the air in passing through the fuel causes the latter to burn and liberate heat. Part of this heat is carried in the products of combustion to the base of the stack and serves to maintain the necessary high temperature within the stack. This process is unfortunate in one respect. When the fuel burns, its combustible constituents unite with the oxygen of the air and the weight of gas leaving the fuel bed and traveling up the stack is greater than the weight of air entering by the amount of fuel burned. This means simply that the gases entering the stack would be heavier than the air at the same temperature and they must therefore be heated to a higher temperature than would pure air to give the same "draft" at the base of the stack.

STACK AS A PUMP

The stack may now be investigated in connection with a real boiler, considering it a pump, as was done with a blower previously. For this purpose a stoker-fired water-

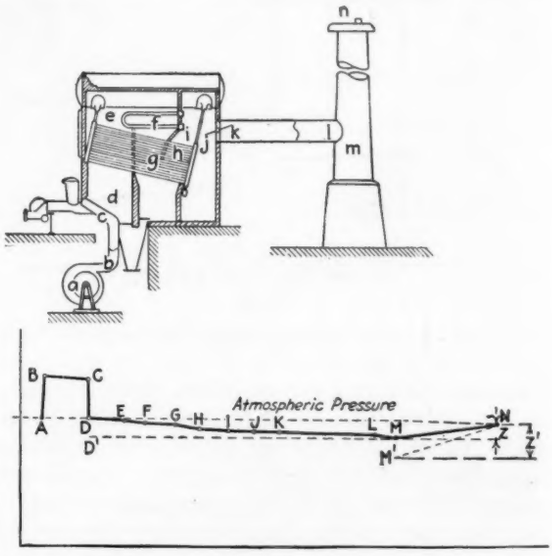


FIG. 14. SHOWING DROP IN PRESSURE IN DIFFERENT PARTS OF BOILER

tube boiler supplied with a forced-draft fan has been assumed, as shown in Fig. 14. Capital letters on the graph of pressure variation indicate the same points represented by the corresponding small letters in the diagram. The directions taken by the various parts of the graph should be easily understood from what has preceded.

It is obvious that the drop of pressure from D to M is caused by the various resistances offered to the flow of the gas by the different parts of the boiler and setting. If the same low pressure indicated at M could be maintained while no gas was allowed to flow, there would be no loss of pressure between d and m. The pressure at d would therefore have to be the same as the pressure at m

(neglecting slight differences of elevation) and the graph of pressures between d and m would be a horizontal line as indicated by $D'M$. This is merely another case of the difference between static and dynamic conditions previously discussed; with static conditions there is no loss of head, with dynamic conditions there is such a loss.

But the stack itself is a pipe which carries gases when in operation, and there must be a similar loss of head in it under such conditions. Were one to calculate the pressure at the base of the stack shown in Fig. 14 for a given set of conditions by using the method indicated in connection with Fig. 11, a value such as indicated by the point M', lower than M, would be obtained. The difference between atmospheric pressure and that indicated by M'—that is, the pressure difference Z'—is called the theoretical draft and is the pressure difference which would be available under static conditions. Under conditions of flow, however, part of this pressure difference or driving force is used in the stack, so that only the smaller pressure difference Z remains available for overcoming the resistances in the boiler and flues.

Gas Velocity and Resistance

The frictional and similar losses in such things as pipes, flues and stacks increase approximately with the second power of the velocity of flow through them. Since greater quantities of gas flow through a stack when the boiler is operated at high ratings than when operated at low ratings, the loss in the stack must increase rapidly as the load increases. If no modifying conditions entered the problem, it would be necessary to have such a high stack to get the necessary available or useful draft at high boiler ratings that the damper would have to be nearly closed at moderate ratings. Fortunately, this is not necessary to any such extent as might at first seem probable.

The temperature of the products of combustion rises rapidly with increasing load, so that the density of the column of gases in the stack rapidly decreases. There is, therefore, a tendency toward increased draft as the load increases. This is partly balanced by the fact that increasing temperature and decreasing density mean increasing volume and therefore increasing velocity and loss, but the improvement is sufficient, within ordinary ranges, to more than balance the increased loss.

Again, with a properly operated furnace the excess air used to insure good combustion can often be decreased as the load increases up to a high rating, and this results in the evolution of smaller weight of gas per pound of fuel as the load increases. This would naturally tend to cause a decrease of stack velocity and consequently an improvement in draft.

It is true that in most installations it is necessary to operate with partly closed dampers at light loads and to open the dampers as the load increases. This is not a necessary property of such apparatus, as it is possible to so design the various parts that the available draft is practically self-regulating, and this has been done in several cases.

Wire-Drawn Saturated Steam becomes more or less superheated. Therefore, the apparent loss indicated by the loss of pressure is partly compensated for and the extra pipe friction is the greatest loss. This loss, in turn, is offset to some extent by the fact that the coefficient of friction of superheated is less than that of saturated steam.

Safety in Refrigerating Plants

The special hazards of refrigerating plants have recently received well-deserved discussion in the columns of the technical press, and among those doing good work in this direction is a recent number of the *Travelers Standard*. As every new industry develops, unforeseen causes of accident become apparent, and while the engineer in charge of refrigerating machinery is exposed in such plants to the ordinary dangers of power-station operation, he is also subjected to hazards which need to be specially emphasized on account of their inherent relation to this specialized branch of mechanical service. The growth of the refrigerating industry, employing high-pressure gases with the attendant risk of explosions and other accidents, is attracting the attention of municipal authorities to such an extent that regulations for installing and operating these plants have been drawn up and put into effect in many localities. Experience will, in all probability, show that most of these will have to be revised, and they are likely to have a history paralleling steam-boiler regulations.

As in almost every other industry, the majority of accidents are avoidable. Leaks in gaskets, through cracks in pipes or other defective parts of equipment under pressure, are fertile causes of trouble. Loss of ammonia is often the result of only small leaks, but where large quantities of ammonia escape explosion may result from the mixture of ammonia, hydrogen, oil vapor and other volatile impurities, particularly where open flames are present. Incandescent instead of arc lamps and self-closing doors between the boiler house and rooms where leaks are liable to occur are important safeguards. Provision by which the ammonia supply may be shut off quickly from any one of three or four widely separated points is also a valuable means of protection. In case of a heavy leak the availability of oxygen helmets at convenient places will facilitate temporary repairs and perhaps enable a complete shutdown to be prevented.

Too much care cannot be taken to maintain all valves in operating condition. Many valves in a refrigerating plant are seldom used, and unless tested with reasonable frequency tend to rust in the stuffing-box gland and on the threads of the packing nut. Piston rings in compressors have given less trouble since the snap ring has been used. While the installation of a relief valve in a bypass or in a connection between the discharge side of the compressor in front of the stop valve and the suction side of the compressor in front of the suction stop valve will give protection against excessive pressure in the system, objections against this practice have been voiced, and it is hoped that the investigations into this phase of refrigeration safety now being conducted will result in recommendations applicable without apprehension.

In compressing air the engineer should not use a machine that has recently been used to compress ammonia, and in opening gage-cocks it is safer to stand at the side rather than at the front of the glass. Such precautions as standing at the side rather than the front of compressor cylinders and refraining from calking pipes or tightening nuts and fittings under pressure are generally understood but often disregarded. Valve breakage is the most frequent cause of compressor accidents and is due principally to unnecessary wear, improper cushioning or to deterioration of the metal.

Care in testing initial installations of refrigerating machinery is vitally important. Even though the equipment be tested at the factory and found satisfactory, a further test after assembly should be considered essential. It is customary to lubricate compressor-cylinder walls with oil before starting a test, and more or less oil is forced into the piping by the compressor, with resultant pocketing, heating, vaporization and sometimes an explosion if the temperature rise is extreme. Lubricating oil with a low chill point is desirable for regular use, but a high flash point is more important on account of the increased safety of the latter. Gradual starting followed by cooling of the compressor is a safer practice in testing than immediate operation from standstill to normal or excessive pressure. The use of butt-welded pipes or of unsupported pipes is considered by many to be undesirable in refrigerating plants.

Water-Tank Controlling Device

The device illustrated herewith is designed to stop a pump when the tank is filled and to start it when the level of the water has fallen to a predetermined point.

The apparatus, Fig. 1, consists of a brass pipe, its length being the distance between high level and low level of the water in the tank. The upper end of this pipe is supplied with a strainer, and a valve and copper float are attached to the lower end. Near the lower end a fitting is provided to which an air reservoir is attached.

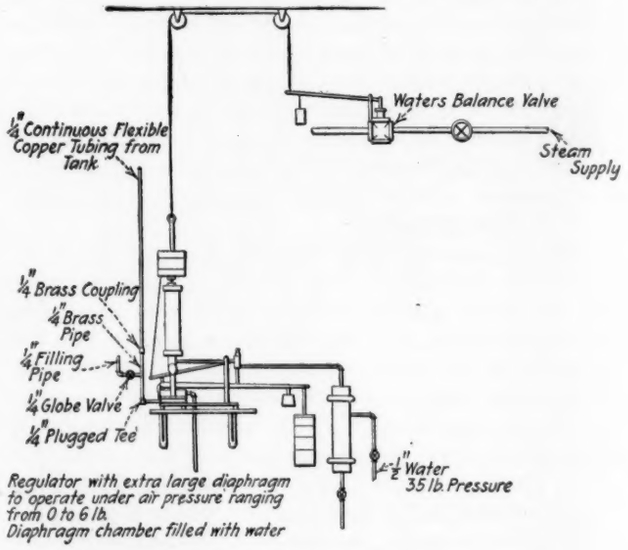

Waters Balance Valve
¼" Continuous Flexible Copper Tubing from Tank
Steam Supply
¼" Brass Coupling
¼" Brass Pipe
¼" Filling Pipe
¼" Globe Valve
¼" Plugged Tee
½" Water 35 lb. Pressure
Regulator with extra large diaphragm to operate under air pressure ranging from 0 to 6 lb.
Diaphragm chamber filled with water

FIG. 2. REGULATOR CONNECTIONS

From the top of this reservoir a pipe is carried to the top of the tank and thence by a flexible copper tube to a damper regulator located near the supply pump. The damper regulator is used to actuate a balanced valve or other device for starting and stopping the supply pump.

The mechanism operates as follows: The water rising in the tank to the top of the pipe overflows into it and compresses the air in the air reservoir. The pressure due to the height of the water in the pipe is transferred through the flexible copper tube to the damper regulator, and it actuates the pump-controlling mechanism and stops the pump. This pressure is held constant until the water in the tank falls to the bottom of the pipe, when the float valve opens and allows the water to escape, relieving the air pressure; and the damper regulator acting in the usual manner actuates the controlling mechanism and starts the pump.

This apparatus has been in operation for four years

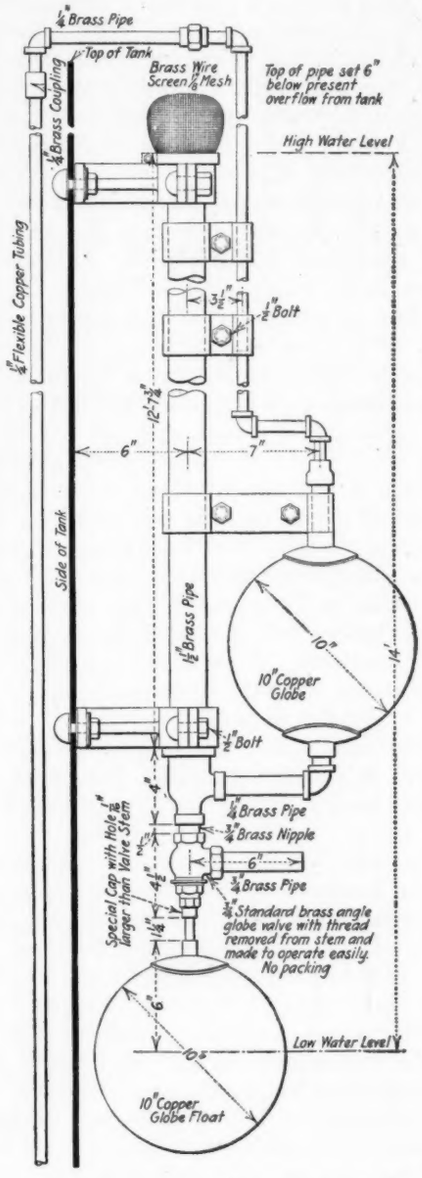


FIG. 1. CONTROLLING APPARATUS IN DETAIL

or more and has proved reliable and satisfactory. It was designed and installed by the Samuel M. Green Co., Springfield, Mass.

Reducing Valves which are too large for the amount of steam they are to pass are usually unsatisfactory. Either they will open and close continually and chatter violently, or will stand in a position nearly closed and become steam cut and leaky. It is more satisfactory to use two small valves in parallel, one set slightly heavier than the other, so that one will supply steam up to its maximum capacity before the other opens. Another way is to use one reducing valve equal to about one-half the maximum demand, and a bypass of about the same capacity with a hand-operated valve in it so that when the reducing valve reaches its capacity the bypass valve may be opened wide and the reducing valve will close down and simply make up the shortage. This, of course, requires that an attendant shall observe the pressure gage occasionally.

Editorials

The Unusual in Engineering Education

Operating engineers of New York City and vicinity have recently had presented to them something worthy of comment in the way of engineering education, yet the character of the presentation is centuries old and the subject is indeed not new, though the proper recognition of its importance is growing.

The subject is the central station versus the isolated plant. The presentation is in the form of a three-act play, with real engineering characters, telephones, charts, records, instruments—everything, in fact, necessary in depicting the problem of how an engineer, his employers and the central station proceed with the business of settling the question of continued isolated-plant service or service purchased from the street.

The curtain goes up on the usual scene of a plant where the engineer has tried to induce the management to buy the instruments and equipment essential to obtaining and recording the data required to show the performance of the plant, but where his requisitions have been repeatedly turned down. The central-station representative, being eminently fair, desires not to take his legitimate advantage of conditions and suggests a call after the plant has operated six months longer to determine what it can do. The issue is forced and the long-lacking equipment is obtained and, which is rather important, *used*.

The end of the trial period sees a proud engineer, an enthusiastic management, and a solicitor who, though regretting his inability to "land" the plant, is frank in his admiration of engineer and management. His little discourse at the close of the last conference should be learned "by heart" by every engineer and vigorously applied. It is the same old sermon about most isolated-plant failures being primarily the fault of the engineer, but a sermon whose value will decrease only as the need of preaching it diminishes.

All things considered, the members of Brooklyn, Number Eight, National Association of Stationary Engineers who conceived and who executed the idea deserve commendation. There are some points which bring forth criticism. But then, these men are not playwrights nor trained actors, neither have they rehearsed or produced sufficiently. Time will supply these needs.

To avoid impressions that impair the value of the play, the members must be extremely careful not to seem to advertise any particular make of apparatus. Some of the slides shown during the consulting engineer's talk to the superintendent do this too plainly, to the dissatisfaction of many in the audience. But that this effect is not intentional is evidenced by the fact that parts of the "lines" which were similarly objectionable have been changed, while the slides are undergoing like treatment. When these features, which excite the critic, are removed, the "company" will, in theatrical parlance, "put it over great."

As a suggestion, we would add that when time permits the evening might be made more valuable by following the play with discussion of the question by audience and players.

Merging Hydro-Electric Interests

The reported plan for merging control and ownership of large hydro-electric and utility corporations in Montana, Washington, Idaho, Utah and Colorado will be urged as an additional reason for the speedy enactment of water-power legislation, when Congress reassembles next winter.

Secretary Lane of the Interior Department, father of the fifty-year leasing plan for the disposal of water-power sites in the public domain which was passed by the House and allowed to die in Senate committee in the last Congress, announced a few days ago that the leasing bill would be reintroduced immediately upon the meeting of Congress in December and expressed the hope that it would pass without further delay. Although the Secretary did not say so, it is understood that the water-power bill will be a part of the Administration's legislative program next winter and that the influence of the President will be used to force the measure to passage.

Consolidations and mergers said to be planned in the states mentioned will place under single corporate control about fifty per cent. of the developed water powers in the Western states. In commenting upon this situation, Secretary Lane said:

"Such a consolidation, involving widely separated power plants, inter- and intrastate transmission lines and Federal questions beyond the scope of state utility commissions, emphasizes the necessity for Federal control and regulation in the interest of the public."

It is reported that the Electric Bond & Share Co., of New York, is the parent of the gigantic merger program. The power which would come under the control of the New York company by the consummation of the several mergers that have been made this year or are in contemplation would aggregate more than 565,000 developed horsepower and about 150,000 horsepower of undeveloped hydro-electric energy.

The Bond & Share Co.'s interest in the merger and control of these Western power sites and plants is represented, according to reports, by a holding company recently formed and known as the National Securities Co. The Bond & Share Co., in turn, is known as a subsidiary of the General Electric Co., and the completion of the merger program will give the General Electric practical control of the hydro-electric field west of Denver.

In the taking over of the Utah Light & Railway Co. by the Utah Power & Light Co. some time ago, all the important water-power plants in Utah were consolidated into a single-headed system. The merger of plants in

Oregon and Idaho now proposed, will similarly unite the hydro-electric plants in these states, heretofore owned by the following companies:

DEVELOPED WATER POWER

	Horsepower
Idaho-Oregon Light & Power Co.	7000
Idaho Railway, Light & Power Co.	14,000
Idaho Power & Light Co.	7500
Great Shoshone & Twin Falls Water Power Co.	9000
Thousand Springs Power Co.	3000
Southern Idaho Water Power Co.	5000

These interests have heretofore been regarded as quite divergent. The Idaho Railway, Light & Power Co., which operates the traction system in Boise, has for some time been seeking a consolidation with the Idaho-Oregon Light & Power Co., which does a commercial business in Boise. The Idaho-Oregon Co. was formerly controlled by the Mainlands, of Oshkosh, Wis., but has been in the hands of a receiver for some time, the receivership being forced primarily by the reduction of power prices from fifteen to nine cents as a result of the entrance into that city of the Idaho Light & Power Co., in competition with the older concern. The Idaho Light & Power Co. has been trying to get into the Twin Falls and Pocatello fields also, and there has been litigation because of the action of the Idaho Public Utilities Commission in permitting the company a "certificate of public necessity" to enter Twin Falls and not Pocatello.

In the Utah merger, by which the water powers of the state came under single control, there were involved plants aggregating 112,850 horsepower of developed energy. The projected acquisition of the Washington Water Power Co. by the same interests will give the General Electric Co. control of the following companies in the Northwest:

DEVELOPED WATER POWER

	Horsepower
Montana Power Co.	184,000
Washington Water Power Co.	156,000
Pacific Power & Light Co.	23,750
Colorado Power Co.	42,250
Utah Power & Light Co.	112,850
Proposed Idaho merger	45,500
Total	564,350

The plan of merger proposes that shares of the older companies shall be exchanged for shares of the new holding company, the National Securities Co., and that all the plants will be operated by a big new company to be organized for this purpose.

Among the power plants involved are those at Oxbow on the Snake River and at Horseshoe Bend on the Payette, owned by the Idaho-Oregon Co. The Idaho Railway, Light & Power Co. owns a power plant at Swan Falls on the Snake River. Other plants included are those at the Shoshone Falls on the Snake River and at American Falls, Idaho. All these power sites were on public land and were the property of the people of the United States until within recent years, and practically all of them passed into private ownership for a nominal consideration and without qualification.

There is no control over water-power companies by state utility commissions in Colorado, Wyoming, Utah or Montana.

Without raising the question of whether the water powers can best be developed by competition or by monopoly, advocates of the Ferris bill urged that the drawing tighter of the lines of private monopoly emphasizes the need for legislation now to protect the public's interests in the power sites still remaining in the public domain.

With half the power of the West under single control, it is urged by Secretary Lane and other advocates of the leasing plan and Federal regulation for power sites in the public domain that the Government should perpetually maintain a controlling hold upon these great natural resources, the value of which is not yet fully apprehended. It is pointed out by these same men that state utility commissions cannot do much in protecting public interests against such a great and powerful monopoly, which would be sufficiently strong to dominate the politics of almost any of the states in which it operates.

A small number of Western senators and congressmen who helped defeat the Ferris bill last winter, urged that a leasing system would retard development, inasmuch as it would discourage investment of capital in water-power enterprises, and that what the West wants is development at any price. In the face of the magnitude of the monopoly that will be created by the mergers now projected, it is not believed that this position can be maintained by this element.

"If the water power sites of the West are allowed to pass into private ownership without restriction," said Secretary Lane, recently, in discussing the matter, "it is apparent that it will be practically impossible to regulate or control monopoly in this important resource or to regulate this product in the interest of the consumer. The possibilities connected with the utilization of the water power of the United States are not at this time realized, nor can anyone predict what changes in the method of development and control will be required by the public interest in the course of fifty or a hundred years from now.

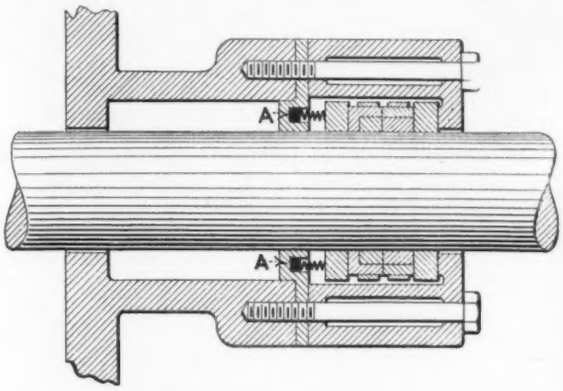
"Only by retaining the fee to these lands and rights in the Federal Government and a measure of control, can the interests of the public, present and future, be properly safeguarded."

Encouraging reports continue to come in showing the favorable attitude of the various states toward the American Society of Mechanical Engineers' Standard Boiler Code. Thomas E. Durban, chairman of the Committee on Uniform Standard Specifications, of the American Boiler Manufacturers' Association and the National Tubular Boiler Makers' Association, has received assurances from J. D. Beck, Industrial Commissioner of Wisconsin, that the State of Wisconsin will "stand by" the recommendations of the committee to the fullest extent and will publish the list of boiler makers who have adopted the Code of the American Society of Mechanical Engineers in the literature of the Commission, in order to encourage the purchase of boilers from such manufacturers. Also an assurance by J. F. Sturgis, superintendent of the Boiler Department of the London Guarantee & Accident Co., Ltd., that all specifications furnished by that company to its assured will conform to the A. S. M. E. Code.

Correspondence

More Spring Tension on Packing

On a 24x48-in. Corliss engine exhausting into a barometric condenser, the vacuum would not go over 22 in. The trouble was located in the metallic piston-rod packing; although it was a good fit on the rod, the tension



BRASS PLUGS UNDER SPRINGS

was insufficient. Brass plugs the size of the hole and ⅜ in. long were put under the springs at *A* to increase the tension. Now we have no trouble in maintaining a 27-in. vacuum.

THOMAS SHEEHAN.

Williamstown, Mass.

Quarter-Turn Shaft Coupling

In the Jan. 26 issue, page 117, there is an article on a "Quarter-Turn Rod Coupling," which, it is stated, was invented by C. P. Hall, of Chicago. Such an appliance has been in use many years and is known as the "Hobson" patent.

JAMES MCCLURE.

Fletcher, N. C.

So far from the quarter-turn rod coupling being new, I know it to be at least twenty-five years old. A fisherman in a little town in Nebraska, where I lived when a boy, carried such a contrivance around with him in his pocket. It was made of two wooden spools and four wires applied substantially as shown in POWER.

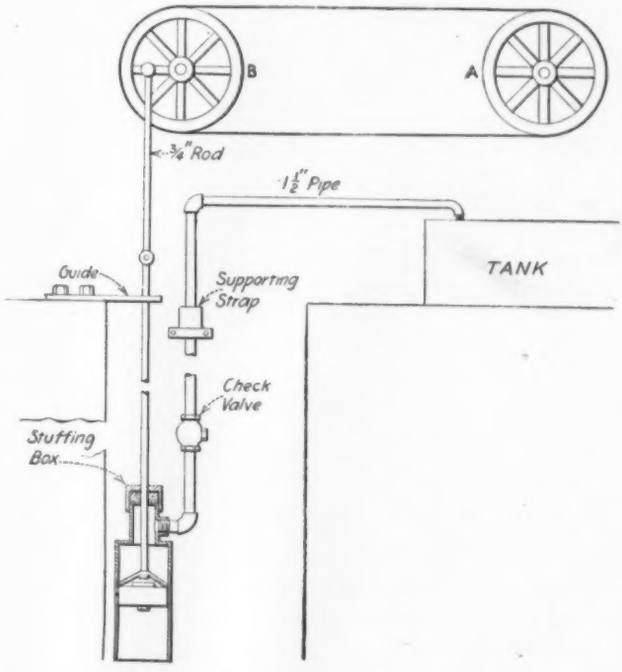
C. O. SANDSTROM.

Kansas City, Mo.

[The quarter-turn coupling referred to embraces the idea of the Hobson patent, of which there are at least two kinds. One consists of a number of right-angled rods which move in perforated guide flanges on the ends of shafts and run at right angles, the rods drawing in and out through the flanges as the shafts revolve. A large angle rod serves as a center bearing. Another coupling is made with four angle rods which slide in holes in the shaft coupling. The difference between this coupling and that described in the Jan. 26 issue is that Mr. Hall's coupling consists of six angle rods and the shaft couplings are made longer, so that when the rods are fully extended the end comes at the center of the couplings, and when the rods are at their inner position they come flush with the inner end of the coupling. In the "Hobson" patent, in one coupling the angle rods extend beyond the inner end of the coupling when at their inner position, and in the other design but ⅓ of the shaft coupling has a bearing on the angle rod when extended. In these two respects the Hall coupling is superior to the original patent, as a greater bearing surface is obtained without the necessity of the objectionable protruding angle rods. The principle of the coupling is the same.—EDITOR.]

Sawmill Engineering

A sawmill was burned down in northern Ontario, fifty miles from a railway, and I was sent out to install a boiler and engine in the new shack called a mill. There was a 55-ft. open well on the property, the water being about 45 ft. from the ground level. The old pumping outfit had



PUMPING RIG MADE FROM FRAGMENTS

been partly destroyed during the fire, and a new one was not included in my employer's contract. The owner of the mill said he would have enough water drawn from the well in pails to fill the boiler and run a test. This looked like a several days' job to me, so with the owner's permission, after the cylinder from the deep-well hand pump was found, although the bottom cap and valve were missing, I rigged up an outfit as shown.

The bottom of the cylinder extended to within a foot of the bottom of the well, and the pipe was supported by straps placed around it at several places. A shaft extended into the pump room, on which there was a pulley. Another pulley with a hole drilled in one spoke was put up over the well and connected to the pump as shown. The first tankful was raised by a couple of men pulling on the belt to turn the pulley. The whole thing was put together in about four hours. I have never been back there (for which I am mighty thankful) but I suppose they have a new pump, although that makeshift affair may still be doing its day's work. It was not a noiseless outfit, by long odds.

JAMES E. NOBLE.

Toronto, Ont.

Some Reasons for Different Rates

The comparison of the sale of electricity to that of ice, by C. R. Seed, in the Mar. 16 issue, although meant to justify central-station practice, illustrates, more than anything else, the injustice of the system of rates in most of the principal cities, as well as in the small towns.

To begin with, let us reconsider the example of Jones, the ice man, together with the figures set forth by Mr. Seed.

To harvest ice *A* (for small consumers):

Cost of labor per ton	$1.00
Cost of machinery, house and equipment, per ton	1.50
Total cost per ton of ice	$2.50

To harvest ice *B* (larger consumers):

Cost of labor per ton	$0.85
Cost of machinery, etc.	0.85
Total cost per ton of ice	$1.70

To harvest ice *C* (still larger consumers):

Cost of labor per ton	$0.75
Cost of machinery, etc.	0.60
Total cost per ton of ice	$1.35

To harvest ice *D* (wholesale consumers):

Cost of labor per ton	$0.70
Cost of machinery, etc.	0.45
Total cost per ton of ice	$1.15

Would it not be reasonably fair to all consumers, large and small, if their rates were based upon the average cost of labor, machinery, house and its other equipment? If this were made the basis of rates for all, the total average cost of the ice per ton, leaving out for the present the cost of transportation, would be

$$2.50 + 1.70 + 1.35 + 1.15, \text{ or } 6.70 \div 4 = \$1.675$$

The fairness of this assumption cannot well be disputed. There is no logical reason why the small consumer should be perpetually burdened with the first cost of the icehouse and its equipment. Of course, the cost of transportation will tend to change the rates somewhat, but transporting ice is far different from the transmission of electricity. A given amount of the latter cannot make any more trips in a unit length of time to a few large consumers than it can to several smaller ones. It may be argued that there is an extra outlay for wire in the latter case, but this item in itself is not sufficient excuse for the great difference in the rates to large and small consumers.

Mr. Seed states that the business of the large consumers causes the whole lot to be cheaper. Yes, cheaper for the large consumers. To further illustrate my point: Suppose that Jones did not cater to the large consumers, but secured several new small customers, which made it necessary to build another story to his icehouse. The cost of ice per ton of lot *A* being $2.50 exclusive of transportation, the cost of lot *B* per ton in this case would be $1.70, which means that the new customers, although not buying any greater quantities than the old ones, are getting their ice for eighty cents less than the original customers, without whom Jones would have had great difficulties in starting in the ice business.

The foregoing does not sound fair, but it is virtually practiced, as Mr. Seed's article proves. If Jones had been a fair-minded business man, instead of having high rates for one set of his customers and low rates for another set, he would lower the rates for the one and raise them for the other until the rates of both were alike; that is, $(2.50 + 1.70) \div 2 = \$2.10$.

Mr. Seed asks, "Which part of the business would Mr. Jones drop?" Let us see. If he drops the small customers *A*, he will transfer the burden of the original cost of the ice plant to the next smallest consumers, or *B*, and will thus raise their rates from $1.70 to $2.50 per ton; he would also have to raise the rates of the consumers *C* and *D*. But he is well aware of the fact that if he juggled with the rates of these large consumers, they would all proceed to install ice and refrigerating machines of their own. He also knows that the small consumers *A* will not install their own refrigerating plants, and that is why Jones goes as far as he likes with these little fellows and why he will not drop that part of his business.

SAMUEL L. ROBINSON.

Providence, R. I.

With no intention of questioning Mr. Seed's entire sincerity in regard to central-station rates, I propose to carry his analogy a little further and present another view of the subject.

Jones cuts 1000 tons of ice at a cost of $2.50 per ton and markets it at a cost of $6.15 per ton, and to make a profit sells at $10 per ton. Smith and Brown, with a new and modern plant, cut 1000 tons of ice at a cost of $1.25 per ton and use it themselves. Jones, seeing a wider field, installs a plant to handle a larger volume of business at a smaller cost per unit of product and proceeds to cut 4000 tons of ice at a cost of $1.15 per ton, and which he markets as follows:

A. Retail 1000 tons, costing $6.15 per ton for delivery, total	$7.30 per ton
B. Retail 1000 tons, costing $4.48 per ton for delivery, total	5.63 per ton
C. Wholesale 1000 tons, costing $1 per ton for delivery, total	2.15 per ton
D. Wholesale 1000 tons, no delivery, to Smith and Brown	1.15 per ton

For the 1000 tons A he charges $8000, or makes a profit of	$700
For the 1000 tons B he charges $6000, or makes a profit of	370
For the 1000 tons C he charges $4000, or makes a profit of	1850
For the 1000 tons D he charges $2000, or makes a profit of	850
Total profits	$3770

Evidently, *B* is the least profitable and *C* the most profitable part of his business, so Jones proceeds to install a new delivery system, so that

A costs $4 a ton for delivery, or a total of	$5.15
B costs $2.50 a ton for delivery, or a total of	3.65
C costs 85c. a ton for delivery, or a total of	2.00
D costs nothing for delivery, or a total of	1.15

But Smith and Brown have now discovered that it is cheaper for them to cut their own ice than to pay $2 per ton for it, and also that some of the class *C* business is attractive and within their reach. Jones, being on his job, proceeds to revise his price list all along the line and then takes for

A. 1000 tons—$7000 (delivery and cutting costs $5150), profit	$1850
B. 1000 tons—$5000 (delivery and cutting costs $3650), profit	1350
C. 1000 tons—$3500 (delivery and cutting costs $2000), profit	1500
D. 1000 tons—$1250 (no delivery and cutting costs $1150), profit	100
Total profits	$4800

and has not only increased his own profit but effectually disposed of any competition by Smith and Brown.

Query: Would Smith and Brown get quite as good rates if it were impossible for them to molest any of the class *C* business?

Would Jones shade the price on class *C* business if Smith and Brown persisted in cutting their own ice, together with a surplus which they offered to class *C* users?

How long would Jones care for Smith and Brown if he did not have the other three classes to produce his revenue?

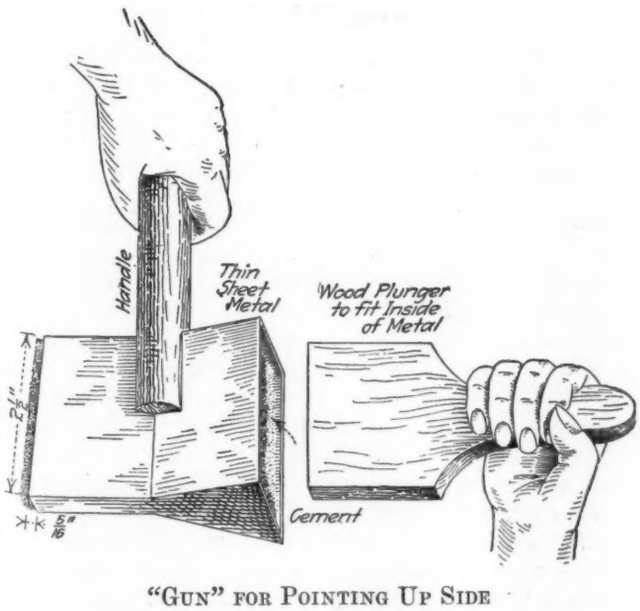
CHARLES L. WARE.

Maynard, Mass.

Boiler-Room Repairs

Most engineers and firemen are not very skillful in laying brick, but there are times when a few minutes spent in pointing up loose brick with cement or fireclay when the fires are out will develop a good job well done.

Getting fireclay or cement in between brick is not always as easy as it might seem. The illustration shows a



"GUN" FOR POINTING UP SIDE

sort of a square squirt gun with which you can fill up the most obstinate crack or hole, and you don't have to be a mason to do it, either.

We always keep on hand a little cement, and whenever a crack shows up and needs attention it takes only a few minutes to fix it, and the job is better than that usually done with the time-honored trowel. Our original model was made from a small tin can and a piece of a barrel stave, which was used until worn out, when we had something suitable made by a tinsmith.

GEORGE C. ABBE.

Brooklyn, N. Y.

Increased the Capacity of the Plant

In the plant where I am employed low-grade slack coal was originally burned, because it was considered cheaper at $1.35 per ton than screened lump at $1.85. Later on, an increased load compelled the burning of the more expensive coal. About this time the price of fuel oil dropped until it was considered more economical than coal, when the grates were removed and an oil-burning furnace put in. This was satisfactory until the price of oil again became prohibitive. In the meantime the load had increased until it was useless to replace the original coal-burning furnace and expect to pull the load without additional boilers.

The management, realizing conditions, allowed a self-styled smokeless-furnace company to place its furnace under one boiler with the understanding that it would burn the poorest southeastern Kansas slack without smoke or clinker. This furnace produced more smoke from less coal than any other I have ever seen, and I have not yet learned how to burn coal containing 18 to 22 per cent. ash and 5 to 7 per cent. sulphur content without some clinker. The "patented smokeless furnace" did not eliminate any of the natural ash content of the coal and one was all that was needed.

It was necessary, however, to get back to burning coal immediately, and on account of the low-set boilers stokers could not be put in with any assurance of satisfactory operation. Therefore, it was up to us to devise and put in a hand-fired furnace that would deliver sufficient overload capacity to pull our constantly increasing load and at the same time meet modern economic requirements and compete with the central station.

The original layout consisted of four 250-hp. Heine water-tube boilers set 5 ft. above the floor at the front and 3 ft. 6 in. at the rear and baffled with T-tile which exposed the lower half of the bottom row of tubes to the flame. The boilers were connected to a steel-concrete stack, 8 ft. diameter and 172 ft. high, which gave a draft of approximately 0.9 in. of water at the dampers and eliminated the necessity of using forced draft, provided sufficient air opening and grate surface were supplied.

The grate surface was extended from 42 in. in length to 56 in., using a shaking and dumping grate having 48 per cent. air space instead of 42 per cent. The T-tile was replaced with a box-tile baffle which protects the unburned gases from the comparatively cool tubes during a critical stage of combustion, which is completed by the time the gases have passed through the combustion chamber, provided sufficient air is admitted over the grates. This feature was supplied by using a rather large damper on the fire-door, the liner of which was perforated according to common practice, and breaking up the air prevents it from stratifying through the furnace. The ashpits were lowered 6 in., which permitted lowering the back end of the grates 10 in., giving them about the same

pitch as the boiler tubes, and adding several cubic feet to the combustion space.

A small amount of steam admitted under the grates has a cooling effect on the molten ash and dampens that already on the grates, thereby preventing the formation of large clinkers. This makes it possible to clean the fires by shaking the grates moderately at 1½- to 2-hour intervals. This steam is supplied by a bleeder from separators on the power units, which were formerly trapped into a feed-water heater. This trap, however, was almost constantly discharging, and it was believed that, as the feed-water heater was large enough to bring water to the boiling point, the condensation would be worth more in the ashpits than in the heater.

With this furnace we can develop 75 per cent. overrating, with but little smoke, burning slack averaging 10,000 B.t.u. and containing 18 to 22 per cent. ash and cleaning fires once in twelve hours. Lump coal of about 14,000 B.t.u. and 10 to 12 per cent. ash is cheaper at $1.85 per ton than slack at $1.35, and it is possible to carry a heavier overload. The smoke seldom gets darker than No. 2 Ringelman chart, and CO_2 averages 12½ per cent., with no CO.

B. M. Babcock.

Pittsburg, Kan.

Experience in an Isolated Plant

The following experience of a friend was interesting to me and may be to others:

"Eight return-tubular boilers with hand-fired furnaces furnish steam for a manufacturing plant with a load almost uniform throughout the twenty-four hours. Various steam-saving appliances had been employed in the engine and dynamo room, but we had never received any special consideration out in the boiler room.

"A so-called efficiency expert had given the plant at large a general going-over, but about all the effect we felt was to have the force cut down and the consoling news that our department was wasting more money than other plants of this class. Our superintendent was deeply engrossed in what he termed the 'output' end of the business.

"Our chief engineer was well along in years and not very favorable to 'theoretical steam makers!' One day the superintendent came into the boiler room and with him our engineer and a young man who was a stranger. The young man said little, but nothing escaped his scrutiny; dampers, draft, coal, ashes and our methods of firing. I felt quite curious and a little uneasy. Sure enough, the next day we heard that the steam plant was to be shut down and city current used. Our engineer said he was powerless to help us as the central-station representatives had shown that it would be decidedly advantageous to buy current, and that the superintendent had decided to try it. There were 12 men in our crew, who would have to look for new jobs and we were a gloomy bunch.

"Since being put in charge of the boiler room I had been studying up on flue-gas analysis, draft regulation, etc., with but little encouragement from my chief. As it appeared that we were to lose our jobs anyway, I pleaded with the chief to make a last effort with the office for our plant. With courage born of desperation, I told him the plant deserved to be shut down on account of our wasteful habits, and that our methods were crude, etc. He took me with him to the office, where the superintendent received us cordially. The chief said nothing, but simply turned me over to him. With nothing to lose, I made a straight drive for my point—that with the proper instruments and boiler-room methods our plant could produce power cheaper than the central station. The outcome, without the details, was that arrangements were made for a three months' trial for which we were supplied with a set of gas collectors, differential draft gages on all the boilers, a new damper regulator and provision for forced draft. Team work and head work also played a large part.

"The draft was kept at what was found by experiment to produce the best combustion. Different fuel-bed thicknesses were found to require different draft and different ash-pit pressures to get the CO_2 up to the bonus line. We were determined to make a success of it and did. A bonus system was established among the firemen, the charts were gone over each week and a bonus declared in proportion to the percentage of saving. In this way the firemen were made stockholders in this economy enterprise. At the end of three months, the trial period allotted, every fireman had developed into an efficiency expert.

"We never knew what the city-current fellow's figures were, but at the expiration of our three months' test we knew we had won. We found that the greatest source of waste we had to overcome was excessive draft!"

Edward T. Binns.

Philadelphia, Penn.

Electrically Controlled Damper Regulator

In the Apr. 13 issue, page 517, is a letter from Henry W. Geare on this subject. Mr. Geare seems to assume that by some means or other he determines how much air is required to burn a certain kind and quantity of coal per square foot of grate per hour, and then arranges to pass sufficient air through to burn this coal. Of course he does not say how this is determined, and I believe he would find it difficult to determine. If, however, he did determine it once, it would not be the same the next time he tried to do it, as the quality of the coal would vary.

Further on in his letter is the statement: "It will be found that under that close regulation with natural draft a much more uniform and higher average CO_2 can be maintained, and the efficiency of the boilers increased, with the resulting saving in coal." Much more uniform and higher than what? Further on he states that "the results with natural draft are nearly equal to those obtained by a balanced draft system without the use of blowers;" which I assume is intended to be a general statement and rather broad in application. What is a balanced draft system without the use of blowers? He concludes by saying that "a balanced draft system without the use of blowers increased [and now he refers to a particular case] the cost of power required to operate such systems." What systems?

V. H. Carples.

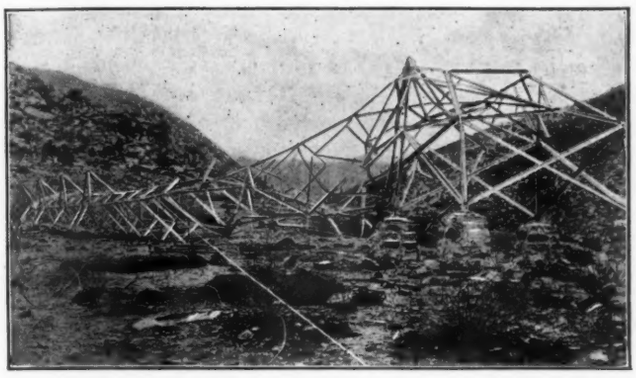
New York City.

A Prey to the Elements

It is usual to see the bright side of transmission lines illustrated in articles on the subject, but sometimes there is something of value to be derived from their failures.

In the present case all the details of the transmission line were worked out most carefully by government engineers, these were checked up, and then followed the construction, inspection and testing. The towers were put up, tested, and everything done that high-class engineering practice considers desirable. This line ran from the celebrated Roosevelt dam to the neighborhood of the Inspiration Copper Mining Co., in Arizona, and passed over a part of the desert in that vicinity.

The line was in service for some time and no more thought was given to its safety, when suddenly about a year and a half ago there arose in the desert a terrific storm that blew and battled, as storms on the Arizona desert can, and soon showed its disregard for engineering and the government and laid about two miles of



ONE OF THE TOWERS AFTER THE STORM

poles or towers to the ground. The condition of one of the towers is seen from the photograph taken shortly after. It will be noted that the tower is clearly buckled and that the rivets and holding parts are still intact. In certain places breaks appear to exist, at first glance, but closer inspection shows that these are the ends of the cross-angles.

A. P. CONNOR.

Washington, D. C.

Liquid Weigher Improved

A liquid weigher, Fig. 1, failed to operate when the temperature of the feed water became as high as 200 deg. F. The vapors arising from the water evidently formed air pockets in the siphons, causing loss of suction, consequently, the buckets would not drain sufficiently to allow them to turn to the proper position to be refilled.

This difficulty was overcome by making two steel crankshafts 2½ in. diameter, and extending from the center of the weigher through the side walls, and attached to the dashpots on the outside. These crankshafts have a 5½-in. throw and revolve in bronze bearings mounted on the channel beams supporting the bedplate. An arm, or lever, extends from the shaft to the bucket, being fastened between the two short pieces of channels under the bucket, Fig. 2; these channels serve as buffers between the bucket and bedplate. A hole 3 in. diameter was cut in the bottom of the bucket and a special valve, Figs. 3 and 4, made to fit this hole.

After the bucket is filled and tilts the water is turned into the other bucket by the deflector with which the weigher was originally provided, and the valve stem is raised by striking a strip extending across the weigher some distance below the bottom of the buckets. After the water has been emptied into the reservoir the bucket

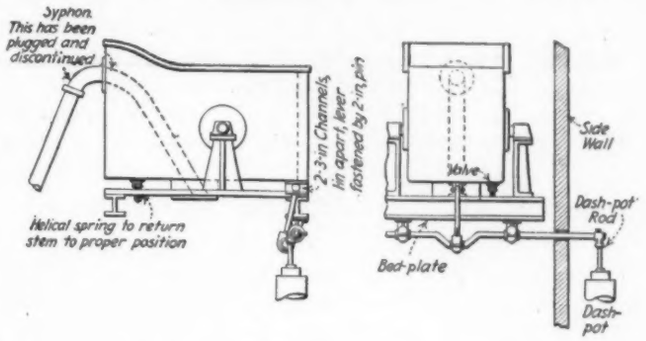

Syphon. This has been plugged and discontinued
2 3-in Channels, 2' 3-in apart, lever fastened by 2-in. pin
Helical spring to return stem to proper position
Valve
Side Wall
Dash-pot Rod
Bed-plate
Dash-pot

FIG. 1. SECTION OF WEIGHER SHOWING THE SIPHON AND DASHPOT

returns to its normal position to be refilled, and the valve stem is forced back into its proper position by the helical spring. Should leakage take place through this valve, it can be stopped by increasing the tension of the spring by means of the nuts on the valve stem.

The size of the valve required will, of course, depend upon the time available for one bucket to empty and return to its filling position. The 3-in. valve mentioned allows a bucket containing 485 lb. of water to empty and return to its normal position in from 33 to 37 sec.

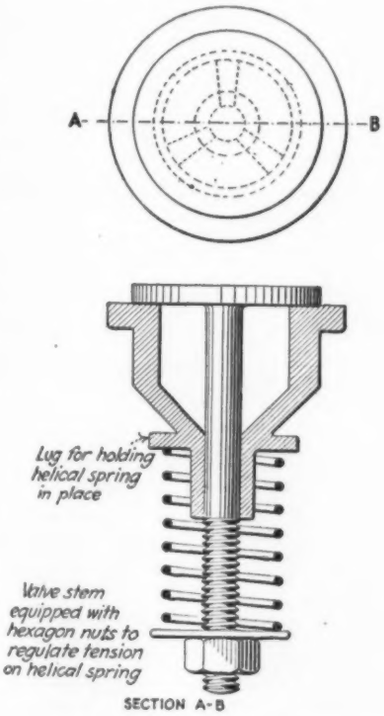

A
B
Lug for holding helical spring in place
Valve stem equipped with hexagon nuts to regulate tension on helical spring
SECTION A-B

FIG. 2. SECTION OF VALVE FOR LIQUID WEIGHER

Any sort of registering device can be used to count the number of buckets dumped in a given time. An ordinary street-car register can be connected so that each time a bucket is emptied it will be recorded on this register. The amount of water necessary to tilt a bucket can be determined by filling one and allowing it to empty into a barrel mounted on a pair of scales. As the buckets are usually filled through one weir, the total amount of water consumed will be the product of the number of buckets emptied, the pounds of water contained in each bucket, and the number of weirs.

After making the above changes the weigher was tested several times before being put into service. The water dumped by the buckets was weighed and the

maximum variation differed from the average of a dozen trials by less than one per cent.

The principal advantage of the weigher (which is a Worthington) as it is now, over the original one, is that there will be no loss of suction on account of the formation of air pockets as there is no siphon effect. The buckets will return to the proper position to be refilled, enabling the operators to keep an accurate record of the total water consumed. Also, the dashspots will give less trouble, as they are no longer submerged.

J. W. Loef.

Ft. Worth, Tex.

Effects of Throttled Indicator Cock

During a test on an ammonia compressor a number of diagrams were taken whose areas gave a capacity smaller than the machine should have developed. These diagrams were similar to those shown in Fig. 1. The re-expansion line appears, which would indicate a large amount of gas in the cylinder at the end of the stroke.

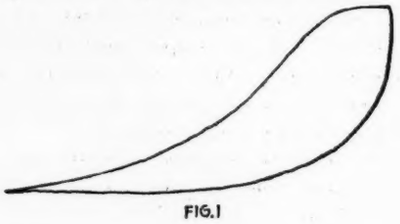


FIG.1

FIG.2

FIG.3

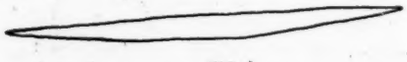


FIG.4

Diagrams Showing Effect of Throttled Indicator Cock

In this particular machine the compressor cylinders were single-acting and there was every reason to believe that there should have been a constant pressure line throughout the stroke and a diagram similar to Fig. 2 obtained.

Investigation and experiment showed that if a series of diagrams were taken, one after another, with the indicator cock opened a little more each time, diagrams with widely varying areas could be obtained. Further experiment showed that diagrams varying from that shown in Fig. 4 to that shown in Fig. 2, depending on how much the cock was opened, could be taken. The reason for the cock not being fully opened was that in trying to have the least possible amount of ammonia escape, the operator feared to open it. Instead of getting an intake line at constant pressure, the line obtained would indicate a decrease of pressure as the stroke progressed. This was due to the failure of the indicator mechanism to respond because of the reduced opening through the valve.

Sidney K. Eastwood.

Owego, N. Y.

Starting an Old Dynamo

A moving-picture man in a small Western town got hold of an old direct-current dynamo which he wished to use with a traveling motion-picture show, his plan being to drive the machine from a rear wheel of an automobile.

The dynamo had lain around for many years and it was a question whether it was in operating condition. As the "movie" man had had some trouble with the local light plant's electrician, he did not feel like calling on him for advice, so he called in a fellow who posed as being every kind of a mechanic. The latter turned on the power and got the machine up to speed, but could get no sign of electricity from it. He then proceeded to test out with a storage battery, and finally announced that the fields must have been burned out and that it would be an expensive job to put the machine in running order. The movie man hated to give up the project and, as the lighting company's electrician had the reputation of being an expert, he decided to try to get him. The electrician responded reluctantly and after calling for the battery used by the other fellow, made the same field tests, but refused to make a positive statement about the machine.

That evening a friend of the movie man chanced to overhear the electrician say that it would not take him fifteen minutes to get the dynamo to generate. The next day this was repeated to the movie man, who immediately called for the electrician again and told him what he had heard. The electrician confessed to making the statement and agreed to make the trial. He connected six cells of a dry battery in the field circuit for an instant and then brought the machine up to speed, and when the proper connections were made the dynamo lighted up an incandescent lamp nicely.

The machine refused to generate in the first case because it had lost its residual magnetism and the resistance of the fields was so great that the storage battery could not send enough current through them to be noticed or to make a spark. When the electrician made the test he wet his fingers and made and broke the circuit, so that when the circuit was broken through the wires it was complete through his fingers. There was enough inductive kick to be felt and to show that the field circuit was all right, though no spark could be seen. The six dry cells were sufficient to magnetize the fields enough to give the machine a start.

The movie man was greatly pleased, but still had things to learn about electricity. The next day he brought the picture machine around and proceeded to try it out. The dynamo generated nicely until he switched on the arc, when the voltage suddenly died completely. All attempts to get a sign of an arc across the carbons were futile, so once more the light company's electrician was appealed to. Only one question was asked—"Did you use your rheostat the same as when using the company's power?" The answer was, "No."

He was told to do so, with the result that an arc was had without further trouble.

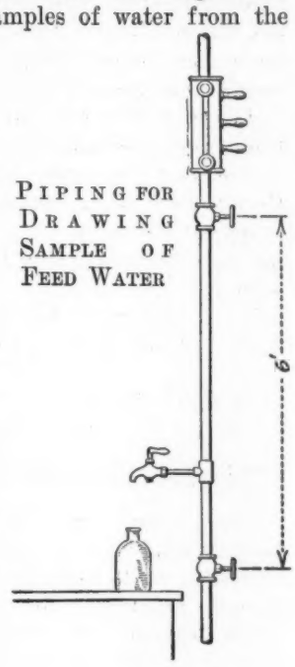
As the dynamo was a plain shunt machine, when the carbons were in contact there was a dead short-circuit across the brushes and nothing to force any current through the field; therefore, the field died and there was no voltage to produce the arc. When the rheostat was in the circuit this resistance prevented the current from flowing through the outside circuit until the voltage was strong enough to build up the field.

G. E. Miles.

Denver, Colo.

Drawing Feed-Water Samples

For taking representative samples of water from the boilers we have found the following to give best results: Each water-column blowoff pipe has an extra valve near the boiler-room floor, and a pet-cock is connected as shown. To obtain a correct sample the bottom valve is opened first, then the one directly beneath the column is opened to blow out the column.



Piping for Drawing Sample of Feed Water

The bottom valve is closed first, then the top one. After the sample contained in the section between the valves has had time to cool, it may be drawn off at the pet-cock into any convenient receptacle.

Edward T. Binns.

Philadelphia, Penn.

Calking Pipe Leaks

In a certain power plant subjected to a working pressure of 100 lb. the lines have given considerable trouble from leakage in the threads. The flanges on the 10-in. main are extra heavy, with the pipe screwed all the way through and peened. In peening these flanges the erector simply beat down the outer edge of the pipe or, rather, riveted it over, but did not peen the full width of the flange. This does not make a good job and prevents the flanges from being taken off, as it tears the threads. These leaks could be stopped temporarily by calking, which was done in the following manner: A calking tool was made with a bit about 3/8 in. wide, then a small groove was cut in the flange with a narrow chisel and this recess calked full of tinfoil. This would stop the leak for a few days, until it worked around the thread to a new place. Some of them were calked all the way around.

The most troublesome leaks were in some short pieces, which were replaced with new ones.

In making the new pieces a full clean thread was cut long enough to screw in the full width of the flange when tight, and to the same taper as the thread in the flange. No "dope" except machine oil to reduce the friction was used in making up the joint, and the pipe was not peened or beaded in the flange. Several nipples were made up in this way and every one gave entire satisfaction without a leak. Some of the other leaking joints were taken down and the entire surface of the joint peened with a heavy ball-peen hammer, but in a few months they were as bad as ever.

The steam line is level and properly drained, with hangers placed not over 10 ft. apart and adjusted to equalize the load on each, but there is some vibration. Steam is not shut off except at long intervals, and there is ample provision for expansion. The principal cause of the trouble is poor workmanship, as those sections, put in properly, give no trouble.

I believe that for ordinary pressure a flange joint should not be peened, and that no "dope" should be used except good oil, because a metal joint is what is wanted, and this cannot be had if the thread is filled up with pipe compound.

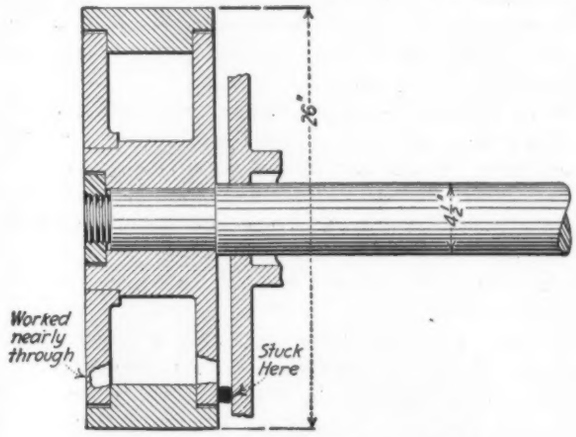
Our experience has demonstrated that a plain screwed joint, properly made up, will hold better than a peened joint.

J. C. Hawkins.

Hyattsville, Md.

Unusual Piston Failure

The piston in our 26x48-in. Corliss engine had a piece of metal of some description left inside when it was plugged up, and after three years of service it worked through the piston on the crank end and was caught between the piston and head, as indicated in the illustration. No damage was done except slightly bending



Piston Wall Worn through

the piston rod. The engine was not shut down for a couple of days, but right after the accident it began pounding badly on the crank end. An indicator diagram was taken, which showed the usual conditions in the head end, but high terminal pressure on the crank end and low compression. It was at first thought that the exhaust-valve stem had twisted, but after studying the diagram it was decided that it would be impossible for the stem to be twisted so that it would lower the compression and raise the terminal pressure. The piston was removed and a hole 1½x1¼ in. was discovered at the bottom of the piston. This was bored out and filled with a 3-in. pipe plug and the diagram was all right.

If any Power reader has had a similar experience I would be pleased to hear from him.

J. W. Dickson.

Memphis, Tenn.

Filling Holes in Commutator

The commutator on a 200-kw. generator contained numerous holes which were constantly filling with carbon and copper dust and short-circuiting the segments, with the result that the holes were constantly growing larger. All the well-known methods for filling holes in commutators were tried, but the filling would stay in only a short time, and it did not seem to make any difference what pains were taken to clean the holes before the mixtures were put in; the filling would blow out just the same.

If more time had been available it might have been possible to try something different, but as this was the only source of supply except a storage battery, it could not be shut down for any length of time.

The commutator contained 95 segments, and there was hardly a bar that did not show some kind of hole. They

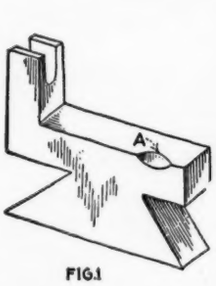


FIG.1

FIG.3

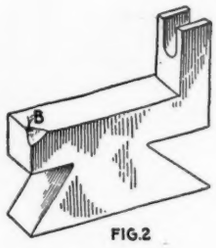


FIG.2

varied from pin holes to the largest, which covered three-quarters the width of the bar and was ½ in. deep and about ¾ in. long. Some were situated as at *A*, Fig. 1, while others were on the extreme end of the segments, as at *B*, Fig. 2.

While turning the commutator would have helped to a certain extent, as it would have taken out many of the small holes, it was not advisable, as enough could not be turned off to take out all the holes without weakening the commutator; also, it would have been a waste of copper, and there probably would not have been enough carrying capacity left in the segments to take care of the current.

As more load was to be added in a short time, the manager decided to purchase another generator. After wiring the old machine so that it could be run in parallel with the new one, and while waiting for a pulley, it was decided to see what could be done with the commutator. It was thought best to take it apart and put in new mica. Two straps of ¼x1-in. iron were bent around the commutator as at *A*, Fig. 3, a ½-in. space *B* being left at the top. Two bolts *C* were inserted to clamp the strap which, in turn, held the commutator in place after the end-plate had been removed. After taking off the end-plate the bolts were loosened on the straps and the mica between two of the segments was removed and then used as a pattern for cutting the new stock.

Then someone proposed that the holes could be filled with solder, each segment being treated separately, so as not to cause a short-circuit. The question of the commutator becoming hot enough to melt the solder was discussed, but as it had not got hot enough in the past to melt the solder at the leads, little apprehension was felt.

First one, then the other of the straps around the commutator, was moved to the segment that was to be taken out, the opening in the strap coming directly over the segment. After unsoldering the leads the segment was moved to the first strap, and the bolts were taken out to allow the ear of the segment, which was higher than the strap, to pass. The bolts were then put back and tightened, and those of the other strap taken out, so that the segment could be removed.

Where the holes were not too large they were filled with solder, the segment having been heated with a blowtorch. On some of the largest holes the segment was laid down flat and a dam of clay built around the hole. The segment was then heated and the hole tinned, and enough solder melted to fill it. After cooling, it was filed off level so as to conform to the rest of the segment and was put back in the commutator. What is commonly known as "hard solder" was used. About thirty segments were treated.

The new mica was put in where needed, and after the leads were soldered on the segments the end-plate was put on and the straps taken off. The commutator was then turned, as it was out of round and the new mica projected above the bars. It was also the means of removing numerous small holes which were not filled with solder.

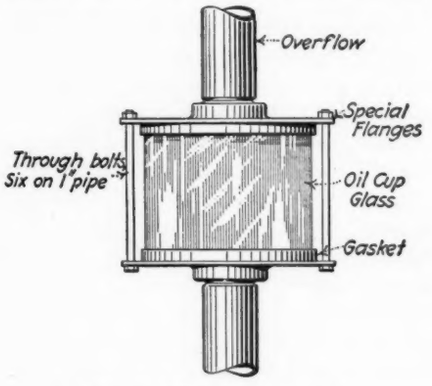
The commutator was still running at the end of five years and had given no trouble.

LEON L. POLLARD.

Fairfield, Maine.

Sight Glass in Overflow Pipe

The overflow water from sealing glands, etc., of high-vacuum apparatus should in all cases be so piped as to be visible to the operator, who can then determine the amount required. He can also detect the presence of undue leakage. A lot of work in one instance was required to locate the cause of a drop in vacuum when the



SIGHT GLASS IN PLACE

overflow was not so piped to a feed-water heater, but if there had been a sight glass, the absence of water, indicating the presence of a leak, could have been noted.

When the apparatus is drained by gravity it is a simple matter to place an open funnel in the line, and where the discharge is under pressure a sight glass can be made as shown in the illustration, using special flanges and a glass from a pressure oil cup with gaskets and through bolts.

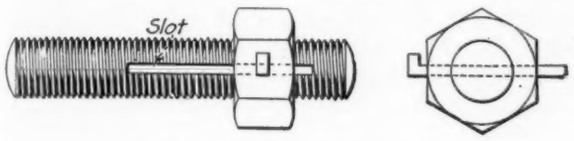
JOHN F. HURST.

Louisville, Ky.

Nut Lock

The nuts on stuffing-box studs sometimes cause quite a lot of annoyance by working off. The illustration shows how I remedied the trouble in a satisfactory manner.

In tightening or loosening the nuts all that is required is to slip the pin out. It is a very easy matter to remove



SLOTTED STUD FOR PIN

and replace the pins while the engine is in motion, because it is not necessary to have the hole in the nuts or the slot in the stud so tight that the pin has to be driven in or pulled out with pliers. A flat wire or key is better than a round one. There is no likelihood of the slot closing and allowing the nut to slip over the threads.

J. B. PROCTOR.

New Orleans, La.

Accident to Pump Plunger and How Repaired

A three-million gallon duplex triple-expansion waterworks pump in a near-by pumping station was a "thorn in the flesh" of the chief engineer ever since it was installed—some eight years previous to the accident. After being in service about three months, it developed a mild pound on one side that was finally traced definitely to the water end, but repeated inspections failed to reveal the cause of the trouble.

The water end, which was of the inserted-barrel type, is shown in the illustration. As there are but few parts in the water end, there seemed to be no reason for the trouble, and several inspections showed that the jam-nut was not loose. The noise became more distinct with time, until the fatal day when the studs *B*, Fig. 1, which held the plunger barrel in place, broke off on one side so that

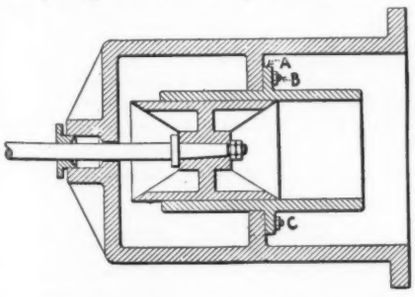


FIG. 1. ORIGINAL CONDITION

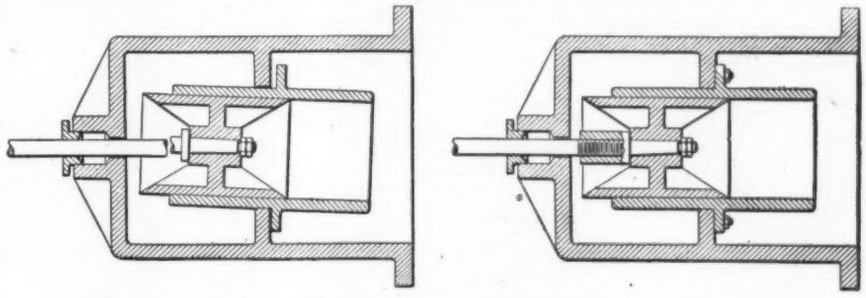


FIG. 2. PLUNGER BARREL DISPLACED AND ROD BROKEN

on the out-stroke the thrust of the rod forced the plunger and barrel off at an angle, as shown (exaggerated) in Fig. 2. This broke the plunger rod off close to the collar.

Upon removing the wreckage the cause of the pound, and also of the accident, was apparent. When the studs *B* were put in at the shop, the threads were not chased down far enough to permit drawing the nuts up against the flange of the plunger barrel, with the exception of three or four which were on one side at *C*. These held the barrel in place for a few months, and then lost motion began to appear at *A*, and grew worse until it had worn in over a quarter of an inch on the flange of the barrel. This continual hammering for several years caused the studs to give way. A new barrel was made and new studs with sufficient thread inserted.

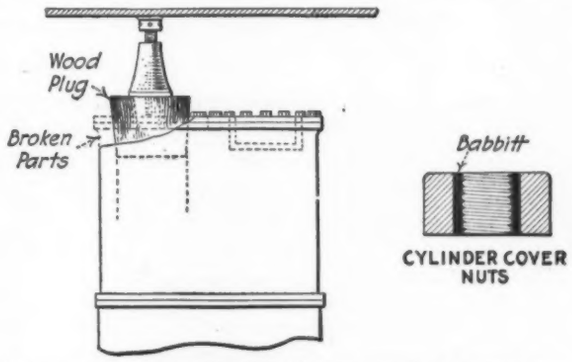
The plunger rod was cut off just inside the collar and threaded. A forging was made which was turned to fit the plunger and looked like a bolt with a large round head bored and threaded to receive the rod, as shown in Fig. 3. A jam-nut was first placed on the rod, as there was enough clearance to accommodate it. The pump now runs better than it did before.

GEORGE H. WALLACE.

Racine, Wis.

Emergency Cylinder-Head Repair Aboard Ship

On board a Transatlantic steamship we had 8 sets of 8x10-in. fan engines for forced draft. They were located in a hot place over the main boilers. The boilers primed frequently, throwing the water into the steam pipes, and several of the cylinder covers were smashed. In one instance the flange was broken so that a new cover could



WOODEN PLUG HELD IN PLACE WITH JACKSCREW

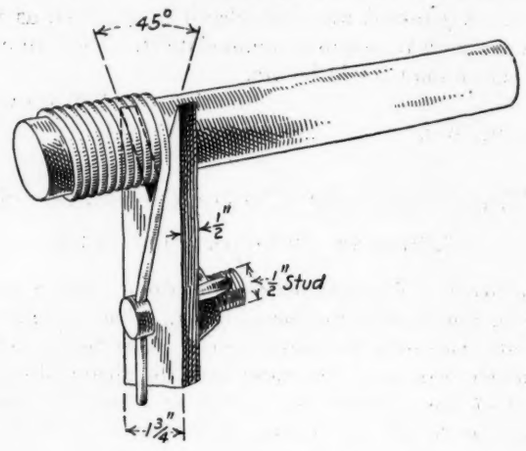
not be bolted on, so we trimmed a block of wood down to fit the bore of the cylinder and, with a sheet of asbestos around it, pressed it down into the cylinder with a screw jack, as shown in the illustration. The engine ran for 10 days, until we reached port, with very little escape of steam.

To prevent the cylinders breaking again we bored out the nuts on the cylinder covers ¼ in. and filled them with babbitt metal, then tapped them out. In case of water in the cylinders it only stripped the soft metal out of the nuts, which were then replaced with new ones and no damage was done We carried a number of these nuts all ready for such emergencies.

New Westminster, B. C. JOHN DOBSON.

Spring-Winding Fixture

The illustration shows a spring-winding fixture. Regardless of the diameter of the rod the spring is to be wound on, the tension is adjustable and the strain is taken up by the fixture itself. It is made from a piece of machine steel ½x1¾x14 in. long with a 45-deg. slot in the end, and drilled to receive a ½-in. stud, and a standard



Position of Fixture in Use

½-in. wing-nut. Drill a hole (say ¼ in.) in the stud close up to the head, and the fixture is complete. To wind an open spring the tool is held in the tool post, getting the lead required by the lead screw, the same as for any other purpose. Closed springs are wound with the fixture held in the hand and the wire will give its own lead.

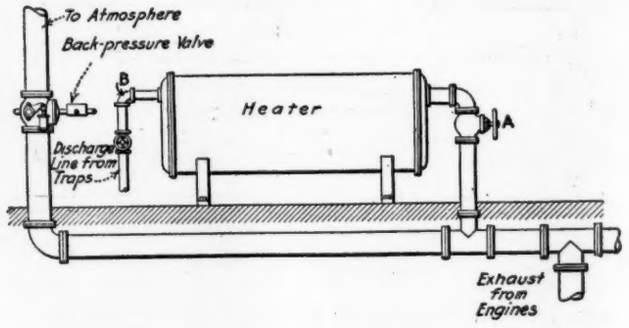
F. L. Young.

Pittsfield, Mass.

Heater Explosions

The illustration shows the arrangement of the exhaust piping, and a heater which was a source of danger that no one had ever noticed until after the head was blown out, resulting in the death of one man.

There were a number of steam traps discharging into



Heater without a Relief Valve

the heater at *B*, and it was customary to partly close valve *A* in case the water became too hot. This valve had an inside screw stem and one could not tell how nearly it was closed except by counting the turns made by the wheel. Just before the accident the feed pumps would not handle the water, so the water tender gave valve *A* a few turns to throttle the exhaust steam. The valve had evidently been left partly closed by the previous watch, so that with the few more turns it was completely closed. As there was then no means of escape for the steam from the traps, an excessive pressure was built up. Some of the traps were out of order and the bypass valves were open, which allowed steam to enter at full boiler pressure. One of the heads was blown out and broken into several pieces. Later, all the heaters were fitted with relief valves.

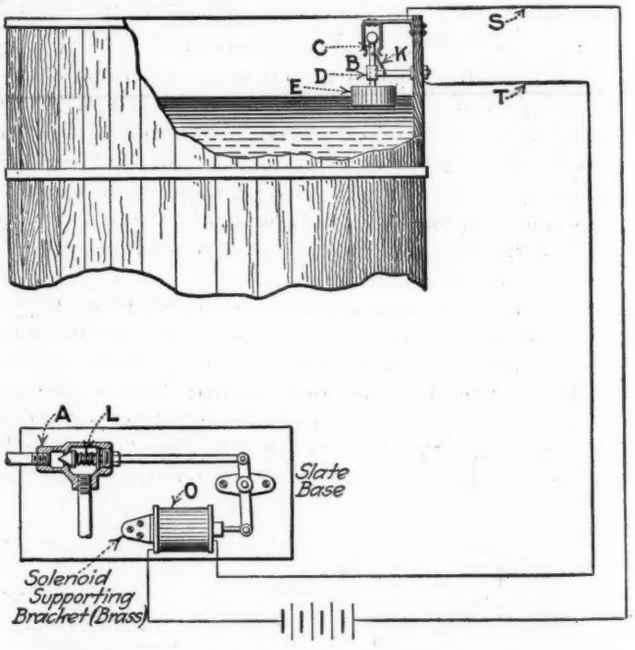
I have seen this same condition in one other plant, which leads me to believe that it may be a common oversight. I think all heaters should be fitted with some form of relief valve.

H. A. Dempsey.

Michigan City, Ind.

Water-Level Control

A mechanism for controlling the water level in tanks is shown. It is adapted to all kinds of water-supply tanks and can be installed at small cost. It consists of a throttle valve *A* operated by the electric solenoid *O*, which is controlled by a float switch *B* in the water tank. This switch consists of a brass spring to which is soldered the wire *S*,



Float and Solenoid Control System

a varnished wood float *E*, in the center of which is fixed a rod *C* with a ball end to make contact with the spring and guided by the arm *D* to which is soldered the wire *T*. Wire *K* is soldered to *C* and *D* to insure a good connection. The solenoid operates the valve through which steam enters to operate the pump.

The operation is as follows: As the water level in the tank lowers, the float *E* descends, closing the electric circuit, throwing the solenoid into operation, opening the steam valve to the water pump; when the pump has raised the water level in the tank to its required height, the float rises, opening the switch releasing the solenoid, and allowing the spring *L* to close the steam valve.

F. B. Hays.

Indianapolis, Ind.

Inquiries of General Interest

Rattling of Exhaust Valves—What causes the rattling noise of the exhaust valves of a noncondensing Corliss engine when running light or when coming to rest after the throttle valve is closed?

R. H.

Under the conditions stated the initial volume and pressure of steam or air in the cylinder may be so small that expansion occurs below atmospheric pressure, and the valves thus become unseated by the pressure of the atmosphere.

Clearance—What is the difference between piston clearance and cylinder clearance?

J. W.

Piston clearance is the distance the piston would have to be moved beyond the end of its stroke to strike the head of the cylinder, and is usually expressed in linear inches, while cylinder clearance is the volume of all the space between the piston at the end of its stroke and the valve face, and is usually expressed as a percentage of the volume displaced by the piston in one stroke.

Obtaining Same Point of Cutoff with Increase of Speed—After increasing the operating speed of an engine, how would the same point of cutoff be obtained for the same load?

C. H. M.

Increasing the speed would require less mean effective pressure, and as with the same point of cutoff there would be the same average pressure per pound of initial, then the increase of speed for the same load and point of cutoff would require a reduction of the initial pressure, obtained either by throttling or by reduction of the boiler pressure.

Determining Brake Power with Indicator—How can the brake horsepower of an engine be determined by use of an indicator and without applying a prony brake?

E. R. M.

The friction of an engine is practically constant for all loads, and as the brake horsepower is the net power developed by the engine, then for all practical purposes the brake power of the engine could be ascertained by determining the highest indicated power it would develop with any kind of load and deducting the power indicated when the engine is doing no other work than overcoming its own friction.

Operation of Automatic Cylinder Lubricator—In ordinary forms of automatic sight-feed cylinder lubricators, how is the pressure of the oil increased so as to force it into the engine steam pipe against the same pressure of steam as that received by the lubricator?

A. A. G.

The condensing chamber of the lubricator is connected by a pipe or passage to the lower part of the oil chamber and, in addition to the steam pressure communicated through the condensing chamber connection, the oil pressure is increased by the pressure due to the head of water of condensation which accumulates in the condensing chamber and its connections.

Allowance for Thickness of Plate—What length of ½-in. boiler plate would be required to form a cylindrical shell 66 in. outside diameter, with butt joint?

G. W. T.

In bending the flat plate into cylindrical form the side that is concaved becomes compressed, the side that is convexed becomes extended and the neutral axis is at the center of the sheet. Therefore, the length of the plate will be equal to a circumference whose diameter would be measured at the center of the thickness of the plate. As this is equal to the outside diameter minus the thickness, and as the diameter measured at the center of the plate would be 66 — ½, or 65½ in., the length of ½-in. plate required for 66 in. outside diameter would be

$$65\tfrac{1}{2} \times 3.1416 = 205.7748, \text{ or about } 205\tfrac{3}{4} \text{ in.}$$

Decrease in Weight from Immersion—When a body is immersed in water, why is its weight decreased by the weight of the volume of water displaced?

J. D. W.

Every part of the surface of the submerged body is submitted to a perpendicular pressure which depends on the depth. If we imagine all these pressures resolved into horizontal and vertical pressures, the horizontal pressures are in equilibrium, while the vertical pressures are unequal and will tend to move the body upward, for the vertical pressures are directly in proportion to the depth. The vertical upward pressures passing through any point in the body will exceed the vertical downward pressure by the weight due to the height of the column of water which is displaced. It follows, therefore, that the total upward pressure will exceed the total downward pressure by the weight of total volume of water which is displaced.

Water Horsepower of Pump—A triplex pump, having plungers 10¼ in. diameter by 24-in. stroke and taking its suction at atmospheric pressure, made 32,200 revolutions during 10 hours' run, pumping against 130 lb. gage pressure per sq.in. What was the average water horsepower and the number of horsepower hours?

F. D.

With three plungers and 32,200 revolutions, during 10 hours' run there would be

$$3 \times \frac{32{,}200}{10 \times 60} = 161 \text{ strokes per minute.}$$

The cross-sectional area of each plunger would be

$$10.25 \times 10.25 \times 0.7854 = 82.516 \text{ sq.in.}$$

and each plunger making 2-ft. stroke and pumping against 130 lb. per sq.in. the water horsepower, without allowance for slippage, would be found by substituting in the usual formula,

$$\text{Hp.} = \frac{P \times L \times A \times N}{33{,}000}$$

the values P = 130, L = 2 ft., A = 82.516, N = 161; that is,

$$\text{Hp.} = \frac{130 \times 2 \times 82.516 \times 161}{33{,}000} = 104.67 \text{ hp.}$$

This must be "discounted" by the percentage of slippage, which can only be known by actual test. Allowing 5 per cent. slippage, the average water-horsepower would be

$$104.67 \times (1.00 - 0.05) = 99.436$$

or for the 10 hours' run, 994.36 water-horsepower hours.

Height to Which Water Can Be Forced by Steam Pump—To what height can water be forced by a direct-acting steam pump where the steam piston is 8 in. diameter, the water piston 5 in. diameter and the steam pressure 80 lb. per sq.in.?

F. J. B.

In estimating the height due allowance must be made for back pressure of the exhaust and the loss of total effective pressure of the steam in overcoming friction of moving parts of the pump, difference of atmospheric pressure exerted on the suction and discharge sides of the water piston, and pressure required for overcoming friction of the water, depending on its velocity through the pump, pipes and passages. These losses depend on the design, construction, adjustment and operating conditions. Assuming that 20 per cent. of the steam pressure is employed for overcoming these losses, then 80 per cent. of 80 lb., or 64 lb. per sq.in. of the steam pressure, would be available for operation of the steam piston in overcoming the static pressure due to the height to which the water is forced. As the area of the steam piston is

$$8 \times 8 \times 0.7854 = 50.2656 \text{ sq.in.}$$

the total pressure available for this purpose would be

$$64 \times 50.2656 = 3216.9984 \text{ lb.}$$

and as the area of the water piston is

$$5 \times 5 \times 0.7854 = 19.635 \text{ sq.in.}$$

the static pressure pumped against could be

$$3216.998 \div 19.635 = 163.84 \text{ lb. per sq.in.}$$

At the ordinary temperatures of water, each pound pressure per square inch would be equivalent to the pressure created by a column of water about 2.3 ft. high, and therefore, for the conditions assumed, the pump would force the water to a height of

$$163.84 \times 2.3 = 376.83 \text{ ft.}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—EDITOR.]

Fink Lubricating Oil Frauds Still Alive

[The following is taken in its entirety from the pages of the *American Machinist* in the hope that it may come to the attention of some intended victim before he is separated from any real money.—EDITOR.]

Those who remember the exposure long years ago, in 1884 to be exact, by the "American Machinist" of the alleged lubricant put out by Henry (sometimes known as John) Fink are likely to be surprised to learn that he is neither dead nor sleeping, but is still on the job, although his field of endeavor has been removed to the Southwest and the Pacific coast. Nor has his method changed particularly, as was discovered in a recent visit to one of his railroad victims.

Taking care to keep away from the mechanical department, he approached the executive offices with a fine collection of alleged testimonials handsomely bound in morocco covers. These and his winning ways, backed by the apparent evidence, secured the cash.

In this particular instance, the mechanical superintendent was an old reader of the "American Machinist" and also possessed of an excellent memory. As soon as the recipe, which had already been bought and paid for by the executive department, was sent to him, he recognized it as an old friend—or enemy. Making a few extracts from the "American Machinist" of 1884-5, he sent them to the executive offices to show how badly they had been stung. The formula is practically identical with the one purchased and is given below.

Since then he has answered a number of inquiries from railroad and other shops along the Pacific coast as to the value—or rather, the lack of value—of the lubricant, for as soon as Fink secures a victim he immediately turns him into a club to force others into line.

GUARDING AGAINST SIMILAR ATTACKS

For the information of those who do not remember the original exposure and who wish to be thoroughly armed against being victimized, we refer to the bound volumes of the "American Machinist" for 1884-5-6. The original article will be found on page 7 of the Mar. 22, 1884, issue; the others following on page 57, Apr. 12; page 4, May 10; page 7, July 12, and page 8, Dec. 27.

The following year tells of his Canadian exploits, his indictments, and the inability to find him when suits were attempted.

He was written to regarding the compound before the first article appeared, but instead of proving his claims, he answered: "We hereby notify you that any item your paper may publish which will injure us in any way we shall most certainly hold your paper responsible for."

The best-known firms in the country fell victims to his wiles, paying from $100 to $700 for the recipe. After being bitten themselves, they came forward with letters relating their experiences, instead of allowing others to become victims owing to ignorance in the matter. Publicity is the best safeguard against such methods, and we shall be glad to hear from all recent victims, in order that the fame of Fink may precede him and make his efforts unprofitable, if nothing more.

DIRECTIONS FOR MANUFACTURING FINK'S PATENT LUBRICATING OIL MIXTURE

To make 48 or 50 gal. of the mixture, take 15 to 17 lb. best lump lime, 22 oz. pulverized french chalk, 20 oz. carbonate potash, 16 oz. calcine magnesia, and 20 oz. pulverized borax. Put these ingredients into a barrel with the head out and add three or four buckets of hot water. After all are dissolved, fill the barrel with cold water, stir the mixture thoroughly and let it settle for about seven hours. After it is perfectly settled and clear, mix the clear water of the mixture with the oils you now use, in the following proportions.

For engines and cylinders take 17 gal. of lard or cylinder oil, 3 gal. of castor or machine oil, 20 gal. of clear mixture, or 40 gal. clear mixture to give it more body. To lard oil or any animal oil or greases: Light oil, mix one-half oil and one-half clear mixture. Heavy oil, mix one-third oil and two-thirds clear mixture.

To mix any kind of machine or black oil, take 15 gal. of any kind of machine or black oil, 5 gal. of lard or animal oil or cheap grease, 20 gal. of clear mixture, or 40 gal. of clear mixture to give it more body.

These proportions may be varied or changed according to the oils or greases used, the climate, or for various reasons to suit the machinery where oils or greases are used.

Put these ingredients into a barrel with the head out and stir them with a paddle. Do not stir the mixture more than once. Use nothing but clear mixture to mix with oil.

If not strong enough add more ingredients to the barrel of mixture. Rinse the barrel before making a new quantity of mixture. Throw away the settlings in the bottom of the barrel of mixture before making a new quantity. Use the best lump lime and the softest water that can be procured in the manufacture of the mixture.

For paint oil or paint would advise the use of one-half linseed or paint oil and one-half mixture. Then use same as pure oil for painting. For wood oil use same as lard or animal oil in same proportions.

The oils or greases can be used with this mixture to suit any class of machinery or climate, from the very finest and lightest machinery to the heaviest, by using more or less of the mixture. The more of the mixture you add to the oil or grease, the heavier it is.

Perhaps this may sound familiar to some of the victims of long ago.

Recent Court Decisions

Digested by A. L. H. STREET

Child Labor in Alabama—Under a law enacted at the present session of the Alabama legislature, and approved by the governor Feb. 24, 1915, it becomes unlawful to employ any person under 16 years of age in operating or assisting in operating any steam boiler or dangerous machinery.

Use of Streams for Power Purposes—A power company authorized to condemn private property in the conduct of the company's business is not entitled to interfere with the navigable capacity of any of the navigable waters of a state unless such interference is authorized by statute. But it may take the private rights of property of a riparian owner upon complying with the constitutional and statutory provisions relating to the condemnation of private property. (Minnesota Supreme Court, in re Otter Tail Power Co., 151 "Northwestern Reporter," 198.)

Duty to Safeguard Power Machinery—Under the Iowa statute that requires every employer to safeguard dangerous machinery when that is practicable, a stationary engineer cannot be deemed to assume the risk of his employer's failure to safeguard setscrews on revolving shafts connected with pumping machinery. But where an employee relies upon failure to provide guards, he has the burden of establishing the fact of their absence. Then the burden shifts to the employer to show that it was impracticable to safeguard the machinery in the particular instance. (Iowa Supreme Court, Winn vs. Town of Anthon, 150 "Northwestern Reporter" 1036.)

OBITUARY

FRANK W. BALFOUR

Frank W. Balfour, district manager of the Southern California Edison Co., died Apr. 25, at Pomona, Calif. Mr. Balfour came to this country from England in 1886 and was employed in the city engineer's office in Los Angeles. He had been with the Edison company for fifteen years and was its first district manager.

GEORGE L. BAULDRY

George L. Bauldry, chief engineer of the plant of Walter Baker & Co., Dorchester, Mass., died at his home on May 4 after a week's illness with pneumonia. Mr. Bauldry was born 53 years ago at Bourne, Mass., and learned the machinist's trade in New Bedford. Later, he was a member of the Hartford, Conn., fire department. In 1899, after a varied experience, including service with the New York, New Haven & Hartford R.R., he entered the Walter Baker plant as a fireman. By hard study in night school he worked his way upward and in eight years he became chief engineer of the company. In addition to his engineering duties, Mr. Bauldry bore important resposibilities as a citizen. He was a member of the Milton Warrant Committee for two years, and also recently on the committee charged with motorizing the local fire department. A few days before his death he was appointed a member of the board of fire engineers. He was affiliated with various Masonic and engineering organizations and is survived by his widow, a brother and a sister.

A. R. (DICK) FOLEY

"Dick" Foley is dead. When the "Lusitania" received her fatal blow and plunged into the sea off the Irish Coast, Friday, May 7, she took Dick with her.

Mr. Foley, known to all as Dick, probably had as large a circle of friends among engineers and supplymen, both here and abroad, as any other can claim. For about 15 years he was connected with the Home Rubber Co., which deeply feels the loss of one so influential in building up its business. As his friends know, Mr. Foley had made many trips abroad for that company.

Engineering organizations, especially the National Association of Stationary Engineers, have few friends more loyal and helpful than was Mr. Foley. He was a member of the Trenton, N. J., Association, N. A. S. E., and made his home in that city, at 713 Hamilton Ave. The works of the company he so long served is also in that city. He was one of the

A. R. Foley

oldest members of the National Supplymen's Association of the N. A. S. E.

Mr. Foley was in the early 50's. He was born in England, came to this country at the age of 21 and settled in Boston. He is survived by a widow, one son and two daughters. We understand that his body will be shipped to Trenton for burial.

PERSONALS

J. E. Woodwell has removed his office to 8 West Fortieth St., New York City, where he will continue the practice of consulting engineering.

H. S. Collette, secretary of J. G. White & Co., Inc., and The J. G. White Engineering Corporation, has resigned from these companies, and expects to reside permanently in California.

R. J. S. Pigott, formerly mechanical construction engineer, Interborough Rapid Transit Co., New York, has been made power engineer for the Remington Arms-Union Metallic Cartridge Co. at Bridgeport, Conn.

Frank H. Williams has resigned his position with Sperry & Barnes Co., New Haven, Conn., to accept an appointment as chief engineer and master mechanic at John Morrell Company's plant at Sioux Falls, South Dakota.

Prof. W. H. Kavanaugh, head of the Experimental Engineering Department, University of Minnesota, has been appointed a member of the International Jury of Award, Department of Machinery, at the Panama Exposition, San Francisco. He is spending the month of May judging exhibits.

Joseph McNeil, who is well known as a former chairman of the Board of Boiler Rules of Massachusetts, and who recently has had charge of the inspection department of the Boston office of the Hartford Steam Boiler Inspection & Insurance Co., is now stationed in the New York office.

O. L. Remington, general manager, and H. P. McColl, engineer, of the Wm. McLean Co., importers, Melbourne, Australia, are visiting the industrial centers of the country. They are making a study of machinery and apparatus devoted to power uses and have established temporary headquarters at the Hotel La Salle, Chicago.

G. L. Fales has become associated with the Raritan Copper Works, Perth Amboy, N. J. Mr. Fales was formerly superintendent of power, Tennessee Copper Co., Copperhill, Tenn. When he left the latter concern, its employees gave him a fine silver service as a mark of their high esteem and good will. The readers of "Power" will remember him as a contributor of several interesting articles on boiler operation.

ENGINEERING AFFAIRS

The National Association of Cotton Manufacturers held its annual meeting at the Copley-Plaza Hotel, Boston, Apr. 28 and 29. The business sessions were devoted to papers and discussion on concrete construction for cotton mills and on the dyestuff situation as affecting the cotton industry.

A. S. M. E. Legislative Work—At a recent meeting of the Council of the American Society of Mechanical Engineers it was decided that the society's representative on the conference committee of the United Engineering Societies be present at the state constitutional convention and coöperate with the representatives of the other engineering societies in any matters bearing upon their mutual interests. It was also moved that a committee of five be appointed to formulate general principles for the guidance of those who may serve the society in a representative capacity, and particularly when dealing with public questions.

Two Awards by the Franklin Institute—The City of Philadelphia, acting on the recommendation of the Franklin Institute, has awarded the John Scott Legacy Medal and Premium to Herbert Alfred Humphrey, of London, Eng., and to Cav. Ing. Alberto Cerasoli, of Rome, Italy, for the Humphrey pump, a device for raising water by the direct application of the explosive energy of a mixture of combustible gas and air. The Edward Longstreth Medal of Merit has been awarded to the late George A. Wheeler for his escalator (an inclined elevator for transporting persons from one level to another). The basic invention was first disclosed in a patent granted to Mr. Wheeler in 1892, and a number of patents were subsequently issued to him for improvements and developments.

NEW PUBLICATIONS

DIRECT-ACTING STEAM PUMPS. By F. F. Nickel. Published by the McGraw-Hill Book Co., Inc., New York, 1915. Size 6x9 in.; 258 pages; 218 illustrations. Price, $3, net.

This book had its basis in a course of lectures delivered by the author before the students of Columbia University. It is not a treatise on pumping machinery in general, but, as the title implies, is confined exclusively to the direct-acting steam pump. Doctor Nickel's experience, extending over thirty years in this line, not only fits him to speak authoritatively on the subject, but has enabled him to weave into the text much first-hand information concerning the development of this type of pump.

In descriptive matter it is not unlike two or three other books on the subject, although the greater number of illustrations render it, perhaps, more complete in this respect. The treatment of such subjects as the duplex valve motion and compounding are original; the chapter on performance factors, distinguishing between different efficiencies, heads, speeds, etc., is particularly instructive. The text is supplemented by a large number of tables covering pipe-line friction, steam forces and duty, and a chapter on the operation and adjustments of direct-acting pumps will be found useful, especially by the operating man.

JOURNAL OF THE AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

The American Society of Heating and Ventilating Engineers has issued the first number of a quarterly journal. According to the editorial announcement, the new publication is not intended to replace the annual volume of "Proceedings," but rather to present in advance papers to be given before the society. It will also offer a medium for a closer interchange of ideas between members by publishing discussions on the papers, questions asked and answers supplied by the members on any subjects of interest to the organization. The headquarters of the society are at 29 West Thirty-ninth St., New York.

TRADE CATALOGS

Sherwood Mfg. Co., Buffalo, N. Y. Catalog No. 16. Oil pumps, injectors, ejectors, etc. Illustrated, 20 pp., 3½x6 in.

The Deming Co., Salem, Ohio. Catalog J. Power pumps. Illustrated, 190 pp., 7x9 in.

The Jeffrey Mfg. Co., Columbus, Ohio. Bulletin No. 141. Single roll coal crusher. Illustrated, 32 pp., 6x9 in.

The Watson-Stillman Co., 50 Church St., New York. Sectional Catalog No. 92. Hydraulic forcing pumps, etc. Illustrated, 128 pp., 6x9 in.

"Engineering Bulletin No. 10"—The Peterson Power Plant Oil Filter and Accessory Apparatus for Central Oiling Systems is the title of a 32-page catalog recently issued by The Richardson-Phenix Co. of Milwaukee, Wis. This catalog describes the construction and operation of the new Peterson Power Plant Oil Filter, and it is stated that filters of this type having a total capacity of over 1,500,000 gal. are now in operation. Curves are reproduced showing the results of some interesting tests made on oil taken from one of these filters, and a chapter on the necessity of using filters in connection with steam-turbine oiling systems contains much new information. The catalog contains fifty illustrations showing many important installations of Peterson filters and oiling systems. Copy may be had by addressing the company.

BUSINESS ITEMS

John F. Hale, formerly with the Warren-Webster Co. of Camden, N. J., has associated himself with the Consolidated Engineering Co. of Chicago.

To meet the continuously increasing demand for Peerless specialties, the Peerless Rubber Manufacturing Co. has moved into larger quarters at 31 Warren St., New York.

The Jeffrey Manufacturing Co., Columbus, Ohio, has moved its New York Branch from 77 Warren St. to 50 Dey St. George H. Mueller, assistant sales manager of the company, is in charge of this office.

The Richardson-Phenix Co., Milwaukee, Wis., has purchased the patents, good will and manufacturing rights of the Osborne "NoKut" valve and is now carrying a complete line of the various valves in stock. Literature describing the "NoKut" valve is sent on request.

The annual meeting of the stockholders of the Joseph Dixon Crucible Co. was recently held in the company's office in Jersey City. Following are the directors elected: George T. Smith, Robert E. Jennings, George E. Long, E. L. Young, William G. Bumsted, J. H. Schermerhorn, Harry Daily. The officers elected by the Board of Directors are: President, George T. Smith; vice-president, George E. Long; treasurer, J. H. Schermerhorn; secretary, Harry Daily; assistant secretary and assistant treasurer, Albert Norris.

NEW EQUIPMENT

ATLANTIC COAST STATES

The Edison Electric Illuminating Co., of Brockton, Mass., has applied for a permit to build a new substation on Ames St., Brockton. The estimated cost is $3500.

Recent press reports state that the town of Reading, Mass., has decided to extend its municipal electric-light service to Lynnfield, North Reading and Wilmington. The estimated cost of the work is $12,000. Arthur G. Sias, 179 Main St., Reading, is Mgr. and Supt. of the Reading municipal electric-light plant.

The H. B. Ives Co., Artizan St., New Haven, Conn., is having plans prepared for a one-story, brick and steel, 24x44-ft. boiler house, and a 125-ft. stack. R. W. Foote is Arch.

The Eureka Flint & Spar Co., Trenton, N. J., is having plans prepared for the construction of a one-story, 36x85-ft. power house.

The Ebensburg Light, Heat & Power Co., Ebensburg, Penn., is preparing to install one 800-hp. Blake & Knowles open feed-water heater and one Worthington duplex feed pump. E. F. Craver is Gen. Mgr. and Cont. Agt.

The Eastern Pennsylvania Light, Heat & Power Co., Pottsville, Penn., contemplates increasing the output of its plant at Palo Alto, a suburb of Pottsville, by 2000 hp. The estimated cost of the work is $200,000. W. B. Rockwell, Pottsville, is Mgr.

SOUTHERN STATES

Press reports state that the Lynchburg Traction & Light Co., Lynchburg, Va., has appropriated $85,000 for rebuilding its transmission lines. It also contemplates enlarging the Blackwater St. station. J. W. Hancock is Gen. Mgr.

The Parkersburg, Marietta & Interurban R.R. Co. has selected a site in Parkersburg, W. Va., for the location of its new generating station to replace the present power house. The building will be 135x150 ft., and the completed plant is estimated to cost $500,000. Sanderson & Porter, 52 William St., New York, N. Y., is Engr.-in-Charge.

Press reports state that the Baton Rouge Electric Co., Baton Rouge, La., will build a new power plant to cost about $200,000. Donald Stewart is Mgr.

It is reported that the New Orleans Ry. & Light Co., New Orleans, La., will spend about $125,000 in enlarging its power house on Market St.

The Kentucky South-Western Electric Ry., Light & Power Co., Paducah, Ky., will build a new power house in connection with its traction line from Paducah to Murray, Ky. F. M. Smith is Gen. Mgr.

CENTRAL STATES

Bids will be received until noon, May 24, by the Board of Education, City Hall, Cincinnati, Ohio, for the installation of electric-lighting systems in the College Hill School on Maple Ave., College Hill, and the Mt. Airy School, Colerain Pike and Mt. Airy Rd., Cincinnati. C. W. Handman is Business Mgr., Bd. of Education.

The Hilliards Light & Power Co., recently organized at Hilliards, Ohio, with a capital stock of $10,000, will install an electric-light plant to supply the town with electricity. LeRoy Bobyns, T. C. Latham and others are interested.

The Ohio Gas & Electric Co., Lisbon, Ohio, recently organized, plans to establish an electric-light plant in Lisbon. Joseph S. Grayden is interested. Service is now furnished by the New Lisbon Gas Co., which purchases energy from the Youngstown & Ohio River R.R. Co.

(Official)—Bids will be received until noon, May 29, by the Board of Trustees, Miami University, Oxford, Ohio, for alterations and additions to the power plant of the University. The work includes boiler- and engine-room extensions to power building, boiler, feed-water heater, vacuum heating pumps, boiler-feed pumps, power equipment changes and additions. W. L. Tobey, Hamilton, Ohio, is Chn. of Bldg. Com. of Bd. of Trustees. Walter G. Franz, Union Trust Bldg., Cincinnati, is Consult. Engr.

The City Council, Painesville, Ohio, has rejected the terms of the Cleveland, Painesville & Eastern R.R. Co., Willoughby, Ohio, to furnish electricity to the city of Painesville, and has authorized an issue of $35,000 in bonds, the proceeds of which will be used to make improvements and buy new equipment for the municipal electric-light plant.

The City Engineer, Ann Arbor, Mich., has submitted tentative plans to the City Council for the installation of a municipal power plant for lighting the streets and public buildings of the city. The estimated cost is $55,585. Manly Osgood is City Engr.

It is reported that the town of Elizabeth, Ill., is considering the establishment of an electric-lighting system. It is stated that the sum of $8000 has already been subscribed for the purpose.

WEST OF THE MISSISSIPPI

It is reported that a company is being organized to install and operate an electric-lighting system in Ute, Iowa. The estimated cost is $10,000.

The City Council of Hays, Kan., is considering the establishment of a municipal electric-light plant. The estimated cost is $27,000.

Bids are being received by the village of Ceresco, Neb., for the installation of an electric-light plant to cost about $5000. G. Johnson is Village Clk. Grant & Fulton, Lincoln, is Engr.

Bids will be received until May 17 by the Village Clerk of Morrill, Neb., for the installation of a municipal electric-lighting system for the village.

A special election will be held in Tekamah, Neb., on May 18 to vote on the question of issuing $15,000 in bonds for the purpose of establishing an electric-light and power plant. M. S. McGrew is City Clk.

At an election held Apr. 26, the citizens of Victoria, Tex., voted in favor of issuing $40,000 in bonds for the purpose of installing a municipal electric-light plant.

It is reported that the Texas Power & Light Co., Dallas, Tex., has purchased the local electric-light plant at Windom, Tex., and will improve the property. F. R. Slater, Dallas, is Gen. Mgr. of the Texas Power & Light Co.

Bids will be received until May 24 by the City of Montrose, Colo., for the construction of a municipal electric-light plant. It will cost about $6000. E. T. Archer & Co., New England Bldg., Kansas City, Mo., is Engr.-in-Charge.

The Mt. Konocti Light & Power Co., Lakeport, Calif., plans extensions and improvements to its plant to cost about $9000.

The city of Tehachapi, Calif., has voted to issue $8000 in bonds, the proceeds of which will be used for the installation of a municipal electric-light plant.

CANADA

It is reported that the Toronto Electric Commission, Toronto, Ont., will build a new substation at Carlaw Ave. and Gerrard St., at an estimated cost of $65,000.

Classified Ads

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